PARK SCIENCE

A Resource Management Bulletin

Volume 14 - Number 4 National Park Service U.S. Department of the Interior **Fall 1994**

Sequoia National Park Hosts 'Pulse II' And the Beat Goes On. . . .

By Jean Matthews; photographs by the editor

Eleven years after their first "pulse study" in Sequoia/Kings Canyon National Parks (SEKI), Dr. Jerry Franklin, Professor of Ecosystems Analysis at the University of Washington (UW), and a 65-member group of researchers returned to the original sites at the 7000-foot level to see what the passage of time afforded in the way of a stereoscopic view. The scientific disciplines represented by the research team covered the broad range of study angles involved in discerning a total picture. As team members picked up on the ecosystem beat that was first pulsed in 1982-83, what struck the observer was the remarkable evolution of the pulse itself.

The data gathered between June 20 and 25 must await analysis, but the dynamic, generative nature of the pulsing process was immediately apparent. Like a strong eddy, the pulse attracts not only individual researchers (see companion article), but whole long-range research programs. Several of the latter either held overlapping meetings at the SEKI pulse campsite or were represented by individuals, who spun in and out of the action--making their own inquiries and sharing their findings.

Hear Oregon State University (OSU) ecologist (and rotten log maestro) Mark Harmon, holding forth at the pulse group's closing campfire:

"The original pulse studies were a spark that ignited a paradigm shift in research--from single species and single problems in individual parks to an awareness of biotic communities and ecosystem functioning over broader areas that extend beyond park boundaries."

Back in 1980, when Franklin organized a pulse at the Hoh River drainage at Olympic NP (see *Pacific Park Science* Vol. 1, No. 1), he was working for the USFS out of the Corvallis, Oregon Forestry Sciences Lab. A corps of scientists and associates with a tradition of integrated, ecosystem-oriented research had developed around programs centered there. Baseline data to serve managerial and scientific purposes within Olympic National Park (NP), especially the South Fork of the Hoh River drainage, were needed. One objective was to describe the role of vegetation in landform development and the formation of different aquatic habitats. Another was to develop baseline descriptions of the valley bottom forest; another was to analyze the role of dead and down wood and the regeneration of trees in valley bottom forests; another to describe and analyze aquatic habitats and their use by fish; and finally to examine the interactions between Roosevelt elk and vegetation.

Oregon State University Ph.D. candidate and big tree climber Steven Sillett shoots a monofilament line-trailing arrow over a giant sequoia branch 180 feet above ground in preparation for climbing the behemoth. Albeit difficult, canopy research in the sequoias provides an unequalled opportunity for investigating the interactions between the hard-to-reach epiphytes and their hosts. Sillett and his partners collected over 15 different lichens and other epiphytes in four days of intensive research as part of Pulse II.

Seven scientific papers grew out of the Hoh River pulse study. A summary by Franklin stated the major conclusions and described the interrelationships among ecosystem components.

The Pulse I study at SEKI, was described in the Fall 1983 issue of *Park Science*. The study involved plant ecology, geomorphology, hydrology, entomology (aquatic and terrestrial), aquatic biology, forestry, and geography. The focus was largely on collections of basic descriptive data on the stream, riparian, and forest systems at the selected study sites.

In the decade-plus since Pulse I, SEKI's original 6 research plots grew to 23. Nine acid deposition plots were added, as were 8 global change plots (5 in SEKI, 3 in nearby Yosemite NP). Many of the same people were back. Sequoia NP science personnel--Wildlife Ecologist Dave Graber, Ecologists Nate Stephenson and Annie Esperanza, and Larry Bancroft, Chief of Resource Management--were still keeping sweaty fingers crossed as to what the future under the new National Biological Survey (NBS) might hold. Jeff Manley, Natural Resource Specialist; Mary Beth Keifer, park Staff Ecologist; and Dan Driscoe, Forestry Technician,

Continued on page 3

PARK SCIENCE

FALL 1994

A report to park managers of recent and on-going research in parks with emphasis on its implications for planning and management.

CONTENTS

DEPARTMENTS

Editorial

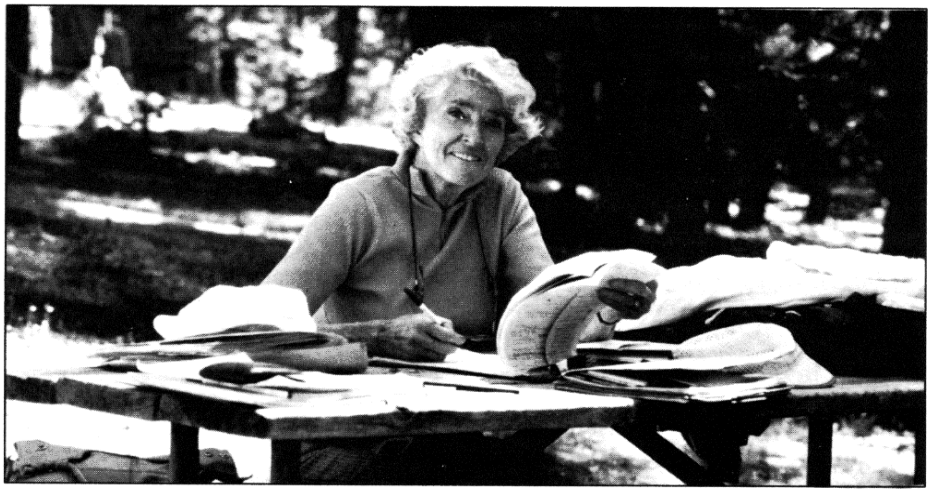
Six months have gone into the transition between editor Jean Matthews (now retired) and myself and this time has made me very appreciative of the strengths of this publication, the interests of its readers, the importance of its supporters, and especially the skills and dedication of Jean.

Last June, the two of us traveled to Sequoia and Kings Canyon NPs to be a part of a specialized kind of holistic ecosystem research, called a pulse study. Working amongst the giant trees and alongside "giants" from the field of forest ecology was a thrill and reemphasized the value of repeating basic monitoring protocols over time. Jean's article (our cover story) explores the pulse study and tells of its importance through the thoughts and actions of its participants. As photographer, I especially enjoyed the activities of the tree climbers, but also took pleasure in documenting the many basic processes of the week. Together, Jean and I formed a friendship and productive bond that has yielded a terrific cover story. Speaking for all *Park Science* readers, I thank Jean for sharing her talents over the years as a writer, editor, and steward of our earth, and invite her to continue contributing thoughts, articles, and editorials to the bulletin from time to time. Best wishes in your retirement, Jean.

The rest of the articles this issue range from a third installment of social science research on off-trail hiking deterrents in Mount Rainier NP to a profile of the people and products of the Natural Resources Publication Program, which guides *Park Science*. Several items deal with wildlife; they include pieces on Florida panther radio collar signal calibration and recommendations for managers of parks with mountain lion safety issues. On the other end of the spectrum, geologist Wayne Hamilton interprets the geologic history of Zion NP through the comparison of fossil mollusks with those found there today, while University of Maine CPSU leader Allan O'Connell describes the benefits of using a labrador retriever in a Gateway NRA research project. We also see a summary of a developing Global Change Program project that will correlate glacial advances and retreats with climate in the Pacific Northwest.

Altogether, the materials represent park areas and interests from all over the country. Contributors include a good balance of biologists, resource managers, National Biological Survey (NBS) scientists, and

Continued on back cover



Enjoying a week out of the office and away from her computer, retired *Park Science* editor Jean Matthews interviewed scores of scientists and their assistants in preparing this edition's lead article.

Sequoia Pulse . . . and the beat goes on *(cont'd from p. 1)*

completed the SEKI staff on hand. Longtime Senior Scientist Dave Parsons attended Pulse II as a final farewell. He was leaving not just the park, but the Park Service (See article on page 8).

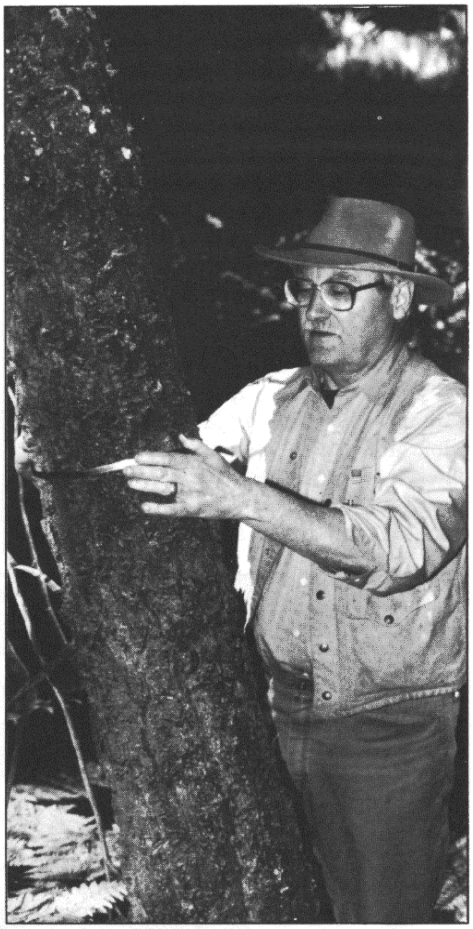
Stream ecology studies begun in 1983 were on hold because their personnel were needed for intensive aquatic sampling for the Coastal Oregon Productivity Enhancement. But two new strings to the pulse bow were the canopy architecture and epiphyte ecology study begun in the permanent reference stands, led respectively by Robert Van Pelt of UW and Steven Sillett of OSU, and the forest floor epiphyte study, led by Dave Shaw.

OSU Research Associate Steve Acker led the team investigating changes in three reference stands (riparian, white fir, and mixed conifer), and found pronounced evidence of mortality. Gregg Riegel, a major organizer of the 1983-84 Pulse I study at SEKI, reported that almost 30 percent of the sugar pines tagged in 1983 had died and a much higher percentage of the remaining trees are infected with white pine blister rust, paving the way for beetles as the proximate cause of death. Acker's team also recorded what was found in the Jeffrey pine and the two giant sequoia reference stands. All these data will be reviewed, verified, and entered by Acker into OSU's Forest Science Data Bank, whose establishment was supported in large part by the National Science Foundation (NSF).

Ruth Kern, Duke University graduate student working with the Global Change Program, reported on her investigations into regeneration in mixed conifer zones at the 5000- to 7000 foot elevational level. In one approach, she enters the permanent reference stands and plots seedling patterns of regeneration in relation to light patterns. Baseline information useful to the parks will come from models that predict seedlings survival and that show whether there is a repeatable pattern for success or whether the reality is too random to make a difference. So far, her results indicate that survival and growth are strongly related to light, but almost not at all to water.

Continued on page 4

In the shadows of huge sugar pines (*Pinus lambertiana*), this sappling struggles to compete for limited sunlight. Researcher Gregg Riegel, with the OSU Silviculture Lab in Bend, Oregon, documents the tree's vital statistics, noting poor general health and the presence of white pine blister rust (*Cronartium ribicola*), a nonnative fungus and pathogen that has become more prevalent in the ten years since Pulse I.



Pulse pioneer Jerry Franklin chips in with the basic pulse work: remeasuring trees from the six permanent study plots originally laid out and surveyed as part of Pulse I and assessing them for growth, vigor, disease, and causes of death. Researchers hope to learn more about the health of the mixed pine forests and sequoia groves nearby and the factors responsible for any changes of the past decade. Preliminary findings suggested greater mortality in the Jeffrey and sugar pine forests than ten years earlier.

Sequoia Pulse *(cont'd)*

Art McKee, Site Director at the USFS H.J. Andrews Experimental Forest in Oregon, who sampled the original riparian plots for vegetation diversity (along belt transects on three streams), was back to measure changes. In 1994, in addition to resampling streamside vegetation, for comparison his team sampled species richness in surrounding uplands. A somewhat surprising early indication is that vascular plant species, while they are more diverse as expected in riparian zones, are not more than two- to three-fold richer than upland zones. The four- to five-fold greater diversity that had been expected for plants *did* hold true for riparian "critters" compared to critter numbers in upland situations.

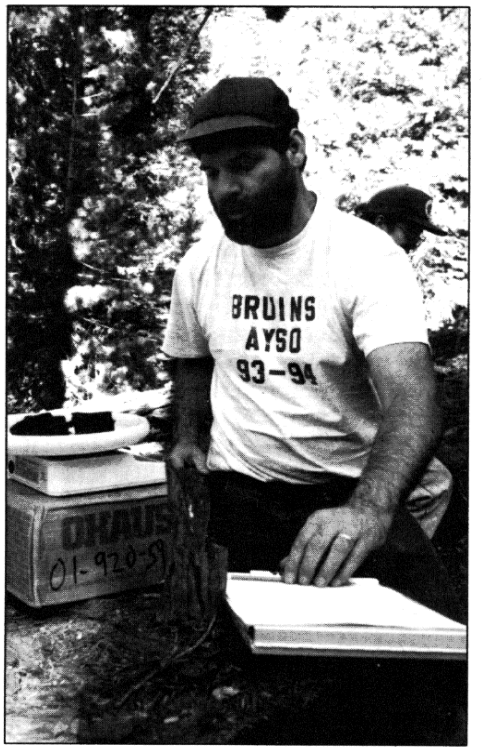
Mark Harmon, author of "Ecology of Coarse Woody Debris in Temperate Ecosystems" (in *Advances in Ecological Research,* Vol. 15, 1986) began investigating SEKI "dead" wood during the 1982-83 pulse. Harmon revels in decomposition. "Sequoia National Park," he said approvingly, "is a very rotten place." He points out that the "so-called 'live' trees consist of no more than five to ten percent living tissue--a biological desert. Now a *dead* tree," he says, his eyes beginning to sparkle, "is about half living matter."

Harmon and his rotten loggers found in 1994 that downed sequoias had remained almost as they were 11 years before, whereas white and red fir logs showed such rapid deterioration that some previously recorded simply no longer existed. Carpenter ants, termites, and white and brown rot fungi can't get a meal out of sequoias, but fir logs decay so fast "they almost vaporize" in Harmon's words.

The Sierra Nevada sequoia stands offer an unparalleled opportunity to study the swings of climate over thousands of years, and such a magnet is drawing top drawer scientists into the pulse. Malcolm Hughes, Director, and Lisa Graumlich and Thomas Swetnam, associate professors, all from the Tree Ring Lab at the University of Arizona, reported findings from dendrochronology and fire scar studies that make possible reconstruction of the spatial and temporal patterns of surface fires in five giant sequoia groves for the past 1,500 years. The extent, the intensity, and the seasons of fire in general correlate with the climate. Multidimensional disturbance (fire) patterns now in hand show fire regimes by elevation. Beginning with the chaparral level, fires occur every four years or so, becoming less and less frequent at higher elevations. The upper tree line also has moved up and down over the years in response to climate changes.

Sequoia regeneration is spotty, according to the findings of the tree ring people. Sometimes decades go by with none at all, followed by a flurry of successes; disturbance, such as fire, would be a key factor in such an event. The pollen record in the meadows suggests that sequoias may have become established only 4,000 years ago, "which means," Swetnam said, "that these groves are only two tree-lifetimes old."

Malcolm Hughes looked around the campfire and beamed: "I love people who actually go out and *measure,* instead of just having wonderful evolutionary thoughts.



"Rotten logging" is the interest of OSU researcher Mark Harmon who reexamines the decay process in logs studied a decade ago at Pulse I. Since then, many specimens have been all but reclaimed by the forest ecosystem. Among the most important factors in their speedy demise is moisture content: too wet or too dry and decay is retarded; just right, as in SEKI, and mechanisms, such as brown and white rot (fungi), termites and ants, and other creatures from bacteria to black bears, efficiently redistribute log nutrients.

My joy is reading the ancient past through tree ring records. In every giant sequoia, the A.D. 500-year growth ring is either entirely missing or very, very thin. Some particular climatic event is indicated here--probably drought. We find that in the past 80 years, thin rings match a climate of *severe* drought. We're now using that relationship to establish the dates of such severe droughts in California for the last 2,000 years."

Lisa Graumlich's research looks at long-lived trees for what they can tell her about past climate and atmospheric composition, helping her formulate more realistic hypotheses. Data from the ancient past about subalpine forest dynamics (tree rings and fire scars) have provided the basis for a more complex model of past climate. She has found temperatures in the past (A.D. 1100 to 1300) exceeding those of the 20th Century, showing that this century's temperatures, while warmer than average, "are within the envelope of natural variability."

OSU research assistant and sawyer Jay Sexton prepares "cookies" or crosssections of decaying pine for evaluation by his Pulse Study teammates. After measuring diameter and thickness of the sections and then weighing them, the team evaluates the means and rate of decay by comparing samples from the two studies.

"Our investigators at the upper treeline," she continued, "find dead trees; dating these trees shows that the upper tree line retreated around A.D. 1,000--a time of regional drought." She described tree ring evidence for century-long drought in the past. "A drought-stressed tree hunkers down," she said, "so that its bole consists of a mere strip of live cambium, as opposed to a cambial sheath that normally surrounds the entire bole." Then she wondered aloud: "Do they sort of hibernate?"

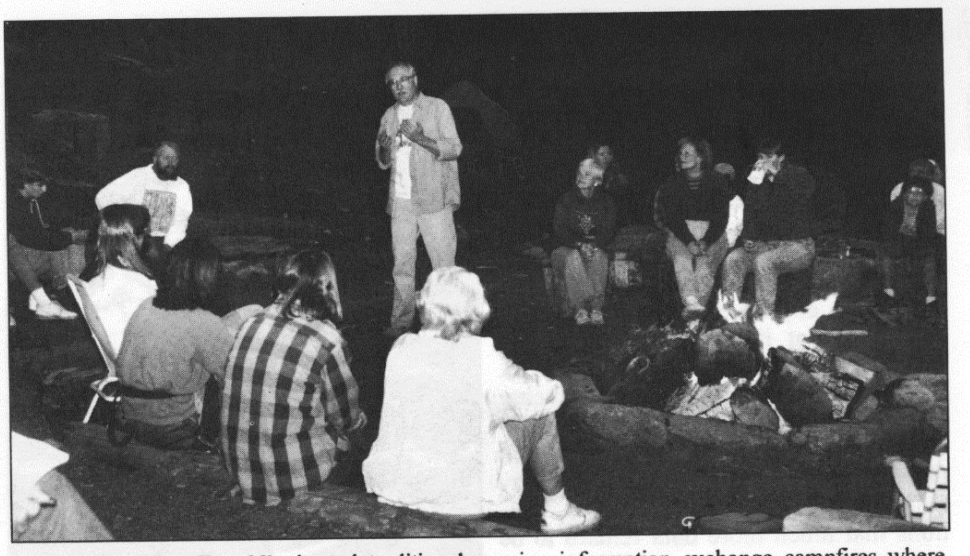
At the opposite end of the research scale lies the microsite work of Pat Halpin. Halpin's studies overlap with the pulse at Log Creek near the Giant Forest. They address the theoretical question of where the dividing line lies between the large (e.g., climate) actions and the tree-to-tree interactions in a particular plot. How long can established local interactions outweigh the effects of major global climate change?

Halpin and his wife spent six weeks in the summer of 1993 in the Log Creek site, charting water flow paths and flow accumulations "at a ridiculously small scale" on three 2-ha sites. They report that they found tree-to-tree interactions more important at the microscale level, but that the larger physical controls are beginning to make themselves felt, even there. Hidden water storage in many giant sequoia groves seems to be acting as a drought survival agent, mainly to downstream trees. Halpin also has found roots much deeper than the 200 cm depths thought to be usual for sequoias--some as far down as 500 cm.

Depressions that once may have been the bases of mature sequoias, now long gone, are holding water up to three weeks longer than the surrounding ground, "and sequoia seedlings are popping out in the flow routes and on the catchments downsite from the mature trees," Halpin reported.

On Friday, the last full day of Pulse II, members of the Global Change Research Program arrived. This formerly NPS program was transferred in its entirety in November 1993 to the National Biological Survey. Global change in the Sierra Nevadas poses such potential problems as loss of biotic diversity, increase in frequency and severity of wildfire, increased tree and shrub mortality from drought and pollution, shifts of treeline and other vegetation to higher elevations, changes in species distribution, increased stress on rare plant and animal species, and decreased snowpack with earlier runoff.

Objectives of the Global Change Research Program are to understand and predict changes in the structure and function of the Sierra Nevada ecosystems, with emphasis on the effects of climate on forest ecosystems (including disturbance regimes), species-habitat relationships, and hydrology. The program provided support for a number of individual research projects and for long-term study plots, data management activities, and cooperative outreach activities. Members of the Global Change project attended the Thursday and Friday night campfires, and several pulse study people sat in on the Saturday meetings of the Global Change group.



Professor Jerry Franklin hosted traditional evening information exchange campfires where pulse takers compared their preliminary findings from the day's hard work with data logged ten years earlier. Carried over from Pulse I, the nightly gathering was also a venue for discussions on the next stage in SEKI's prescribed burning program and reports on Global Change projects.

Early Recognition

The importance of the earlier pulse study was first sounded when then-Superintendent Boyd Evison wrote in the Spring 1983 issue of *Park Science:*

"A remarkable team of 30 scientists, students, and technicians from Oregon State University [arrived at the park in September 1982 and worked for 10 days] from dawn to dusk, carrying out intensive field studies of stream, riparian, and forest systems in a mixed-conifer forest, a giant sequoia forest, and a meadow." Evison described the nightly campfire sessions held by the group and led by Jerry Franklin as "structured, but very lively discussions of project objectives, progress, and applications to Park needs . . . open to Park staff, who were able frequently to provide valuable insights."

Evison applauded the pulse for its attention to "assuring maximum applicability of the findings to on-going Park programs such as basic resources inventory, acid rain research, and long-term monitoring of vegetation changes, the effects of fire, and water quality." He credited the pulse with "providing interdisciplinary information of the kind that most parks unfortunately seem to have little hope of obtaining."

In 1994, the scene of the repeat pulse was a park with no superintendent. Tom Ritter, its latest leader and once head of the NPS Western Region's Science Advisory Task Force, had retired to a cabin in the Puget Sound area. The future of park management was a hazy question mark, but the pulse beat went on. The ecosystem continued to adapt to its own inner and outer conditions; the park research team continued to gather information about how the ecosystems work--struggling to refine their research methodologies, sharpen their focus, and deepen their understanding of both the work they must do on behalf of the systems, and the work they must do to assure their own continued support.

The results of SEKI Pulse I largely dominated the 1984 conference at the University of California/Davis on Research in California's parks, but the papers given there were mostly descriptive and only a very few were published in journals. A dozen years ago, in order to get one's results into the mainstream of science literature, it was necessary to publish in the journals--a process whose timeliness has been aptly described as "proceeding with glacial dignity." Today, the flood of data coming out of pulse and pulse-related research is being fed into data banks--there to await bright hypothesizers who can devise models to test alternative futures.

Continued on page 6

Sequoia Pulse Study . . . *(cont'd from page 5)*

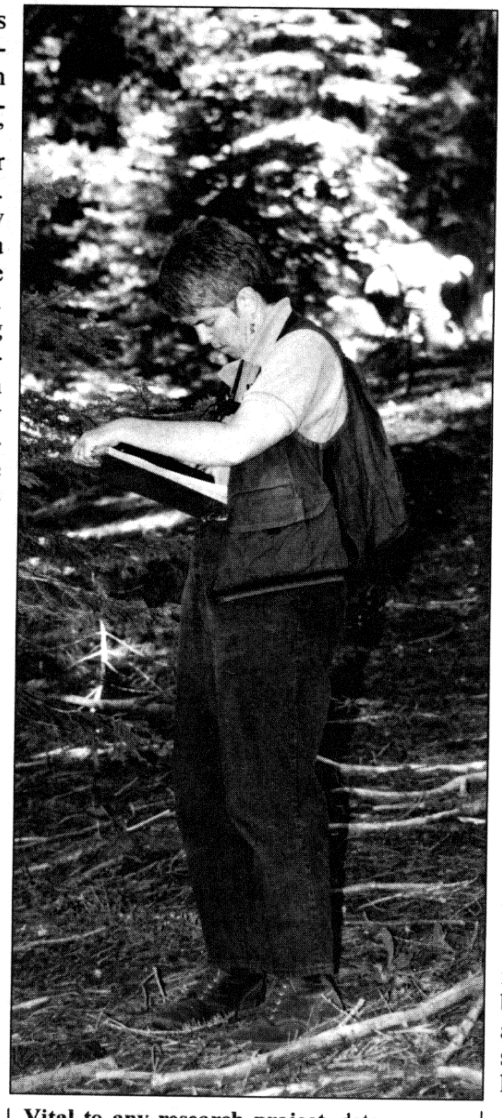
The emerging genius of the pulse lies in this new approach to resource management. No longer will we have to rely on what Nate Stephenson calls "the lumbering, limping, ancient equations of 1988" that give one or two recommendations for park management to accept or reject. Today's scientists are looking confidently toward the day when they can run off a host of "what if" scenarios, using the numbers laboriously collected in the field. From these models they anticipate being able to give management a score of "outcomes" to choose from. However, Sarah Greene, USFS ecologist at the Forestry Sciences Lab in Corvallis, Oregon, cautions that much more data remain to be collected before we can confidently predict ecosystem futures. "A model is still only a weak attempt at best to second guess nature," she warned.

"Models are tools for thinkers, not crutches for the thoughtless."
M.E. Soule`

Given the enormous array of variables inherent in, and affecting, ecosystems, just where the SEKI study plots are heading in the long term is still guesswork. But the pulse crews carrying on the "work" are chipping away at the "guess" in guesswork. Meanwhile, social science research is becoming an increasing necessity, as management is faced with such additional questions as, What do people conceive of as "natural wilderness?" What do they come to parks to experience (and thus what are they willing to support)? How much personal freedom are people willing to forego and how much money are they willing to spend to shape nature to the preferences of *human* nature? (And once we have *that* answer, do we really want to let it guide resource management?)

Franklin's answer, voiced during an evening campfire: "I suspect that the next century will find the 'naturalness' issue to have pretty much gone by the boards. You'll be choosing how you want your parks to look, and managing them to look like that. At Sequoia/Kings Canyon, air pollution from the valley and a couple of degrees of climate warming will make the whole question of 'naturalness' irrelevant."

Or, as a University of Montana philosophy professor fondly remembered by Dave Graber observed some years ago: "We're about to enter an era in which we will treat nature--once lively, vigorous, and stronger than any of us--as a doddering, beloved old aunty, requiring our thoughtful, loving care."



Vital to any research project, data recording was accomplished at Pulse II through the skillful use of electronic data recorders. Sarah Greene tirelessly translated the shouts of distant and near forest pulse takers into keystrokes that accurately portrayed the trees' vital signs, i.e., identification numbers, species, diameter, general health, and prominence in the forest canopy. The data were then downloaded to computers for deferred analysis in Corvallis.

Even as the ecosystem is showing signs of stress and change, so too is the stewardship system. At precisely the time that land managers (e.g., the National Park Service) need the most careful and continuing research, the rug is being rearranged under their science capability. "The transfer of the NPS's Global Change Research Program to the new National Biological Survey," says the 1993 SEKI Annual Report, "leaves many questions regarding the funding and direction of the Sierra Nevada Global Change Research Program." From resource managers across the entire National Park System can be heard a shaky "Amen."

As the latest chapter in the Hairbreadth Harry story of science and the parks is written, two quotations come to mind. The first is from Shakespeare: ". . . tongues in trees, books in the running brooks, sermons in stones, and good in everything. I would not change it." The other is from John Muir, one of the most eloquent tongues the trees ever had: "We all travel the milky way together--trees and men."

And when we have mulled all this, we can pick up the next issue of the George Wright Society's *Forum* and read William E. Brown's latest "Letter from Gustavus," in which he writes:

"No discussion of wildlife, habitat, or ecosystem preservation has any long-term meaning unless the human condition of overpopulation and its amelioration and eventual solution is the overarching context of discourse. All else is fiddling while Rome burns--playing games with research plots, taking record photos before assured destruction. Assuredly all these things must go on, but if they go on in other than a context of human population control, they will have no bearing on coming realities."

Sequoia Ecologist Annie Esperanza may not be as eloquent as the immortal bard, but her words at a Pulse II campfire are as appropriate an epilogue as can be said at this uncertain moment in park history:

"The pulse payoff for the park is the short-term labor force it affords us, the collection of a mountain of data, the stimulation and excitement of the participants who work in this important place and who know they are doing important work here. The long-term payoff is the way it helps us keep long-term research alive here. The tone of acceptance from management is so much better than it was when the pulsing began. We still get resistance, but it's *friendly* resistance.

"Research has become more institutionalized than ever it was before. We've proved our worth to management. And we did it by 'swarming' them. We dug ourselves deep into the fabric of the park until our work has become as much a part of park management as cleaning the toilets."

Matthews recently retired as editor of Park Science. She now makes her home in Vancouver, WA., where her address is 6010 Riverside Dr., Vancouver, WA 98661, (206) 690-8568.

Project Diversification a Positive Sign for Pulse Future

By the editor

The week of Pulse II was busy with the interactions of researchers from the first SEKI study 10 years ago and leaders of new satellite studies that were added more recently. The Pulse projects had diversified from the bread-and-butter originals of remeasuring the permanent reference stands and reexamining their decay processes to include forest mapping, ephiphyte studies, and others.

Ph.D. candidate Robert Van Pelt of UW brought his expertise in three-dimensional mapping to the Pulse as the groundwork for developing a detailed computer model of a sequoia grove that could be used to answer What if . . . ? questions.

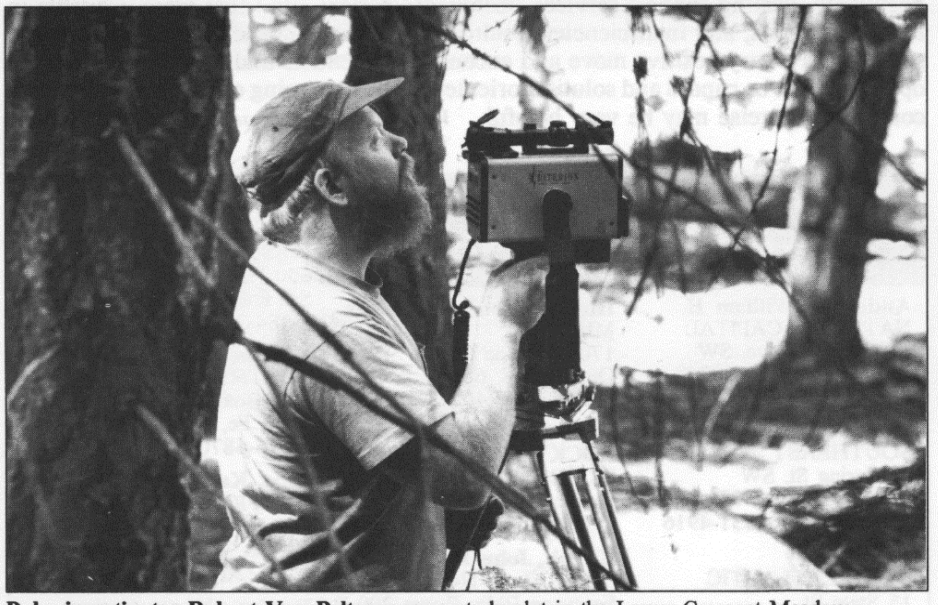
Studying canopy lichens and other epiphytes that live hundreds of feet off the ground in giant sequoias challenged epiphyte niche expert and aerialist Steven Sillett (OSU) and his partners. The experienced tree climbers spent three days scaling four sequoias and examining the relationship between tree height, growth surface availability, and lichen species. Their goal was to produce a detailed map of the distribution of the epiphytes in the tall canopies.

David Shaw's (UW) team used a method for surveying the tree canopies for lichens that allowed them to operate from the ground. The tedious job involved collecting all of the lichens that had fallen from the trees overhead and were lying within a series of 2m-radius plots randomly located throughout the six study plots. Shaw's hope was to determine the diversity of the lichens found in the mixed pine/fir stands, to estimate their abundance in the forest, to associate them species by species with tree species, and to categorize them by function. Both Sillett's and Shaw's work provide an inventory of species diversity, density, and health that will serve as baseline data for future pulses.

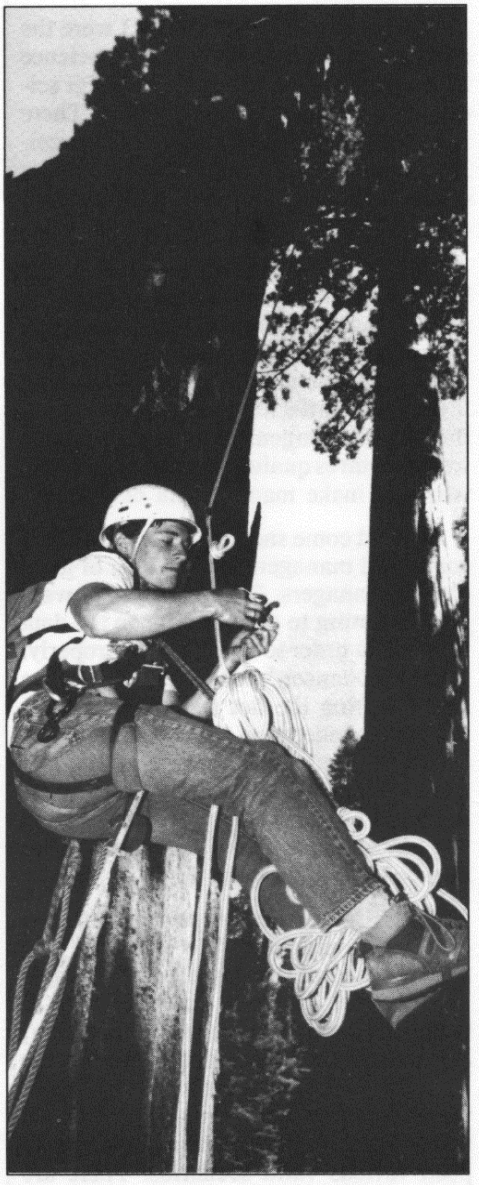
The Pulse approach to research has generated tremendous interest as exemplified by the number, and kind, of participants. The large undertaking appealed to graduate students who wanted to contribute their skills to proven research experiments. The experiments also enticed researchers wanting to learn about the pulse process and imitate it in similar studies elsewhere on the continent. Now recognized as a foundation for long-term research, the Pulse study plots lured scientists to the park to add a layer of new studies to augment the originals.

The Sierra Nevada Global Change Program (initiated by NPS, now run by NBS), while independent of Pulse, coordinated eight projects, many of which used the same Pulse study plots to add to the collective data. Pat Halpin, Global Change research assistant from the University of Virginia, summed up the success and synergism of Pulse in saying, "the beauty of the Pulse Study lies in the permanent plots that have been established and that can be used by subsequent researchers. New projects can be started that build on a foundation of data that will improve with time. Scientists hear about the Pulse and are more likely to sign on because they trust that their own work will contribute to a greater whole. It creates a research situation that compounds."

The growth in participation at Pulse II suggests that the study may operate under its own power in the future while getting to the bottom of the tough questions about the forest ecosystem's health, its dynamism, and its threats. Pulse founder and dynamic leader Jerry Franklin always wanted it this way.



Pulse investigator Robert Van Pelt surveys a study plot in the Lower Crescent Meadow drainage at Sequoia with the help of a state-of-the-art laser theodolite. Van Pelt plans to generate a detailed 3-d computer model or "map" of the giant sequoia plot with enough detail to predict the effects of global warming and other natural disturbance regimes on the forest.



Tree climber Sillett ascends a 280 foot tall giant sequoia (*Sequoia gigantea)* in search of lichens and other epiphytes living high up on the huge trees.

Dave Parsons' Farewell

Editor's note: Parsons is a past research scientist at Sequoia and Kings Canyon NPs. He left the park and the NPS in June to become the director of the Leopold Wilderness Institute in Missoula, Montana. The following are excerpts from an interview he had with past editor Jean Matthews around the Pulse Study campfire.

I came to Sequoia/Kings Canyon in 1973--21 years ago--when there was very little science in the parks. We built the program from a one-person operation to a fairly effective program, with outside scientists, with other agencies, and with academics. It was a cooperative effort that brought science to bear on day-to-day park management.

The pulse studies of 1982-83 were the strategic event that really swung science here into a new, exciting mode. NPS science has struggled over the years. There have been flashes of hope, signs of excellence, and managers who have backed our efforts and who saw our usefulness to management.

But the new direction--the National Biological Survey--is draining the NPS science ranks and threatening to redirect research. It is critical that the NPS and NBS establish effective communication links if the parks are to avoid a return to the days of management by whim. Today's world requires quality scientific data upon which to make management decisions.

We had come such a long way. We had convinced managers of the value of good data to managers. For instance, we were just beginning to get a handle on the data we need in order to manage fire properly. Nate Stephenson's research shows we aren't getting the hot spots we need for sequoia regeneration. David Graber recently showed that under modern fire management we have achieved a fire cycle in mixed conifer stands of no more than 70 to 80 years, whereas the presettlement fire cycle was closer to 15-20 years.

We're not getting anywhere with our current fire practices. We're a long way from the end of the tunnel. Our fire program is still far from perfected. We're facing the need to burn more, burn hotter, and educate the public to the need for this . . . plus figure out how to do it without violating air pollution standards. We need better functional understanding so we can posit various valid scenarios. There are the management frustrations here, and we've had to play whatever funding game is currently hot in order to get money for what needs to be done.

SEKI is a premier study site for long-term environmental research, but it has never been successful in securing a long-term funding base. The lack of an overall commitment to science on the part of the NPS will become even more of a problem now that their researchers have been moved to the NBS.

In addition, many in the scientific community are convinced that there's no point in doing research in the national park system, since the Service on the whole has been negative about accommodating the intrusions necessary for long-term ecological research site work.

It is easy to feel discouraged with the current situation. But it will not do any good to feel sorry for ourselves. We are faced with a new set of rules and we need to make them work. We must work together--NPS, NBS, and other agency and academic scientists and managers--to assure that the NPS is able to meet those needs, and then that the parks are prepared to apply the new scientific findings. It is time to make the system work!

NBS Director Pulliam to Address Problems Faced by Former NPS Scientists

NBS Director Ron Pulliam has appointed Dr. Charles Van Riper III of the agency's Colorado Plateau Research Station in Flagstaff, Arizona, to serve for three months as an ombudsman, or complaint investigator, for the new agency. Acting on reports that the NBS already has too many layers of bureaucracy between field scientists and headquarters, Pulliam felt it necessary to appoint a trusted former NPS researcher, such as Van Riper, to investigate problems and offer realistic solutions. Pulliam has directed the scientist to begin his investigation with former NPS employees now transferred to the NBS because he believes their problems are especially acute and need to be addressed promptly.

During the next three months, Van Riper will be calling on former NPS scientists and present managers to discuss several issues. Van Riper considers his most important area of investigation to be the relationships between the NBS scientists and their parent bureaus. He plans to find out how NBS field stations relate to NPS managers that once supervised them as well as to help the agencies form an ideal relationship. Also on his list of inquiries are questions about overhead costs affecting field researchers negatively, lacking support services (technical, clerical, etc.) that were available in former agencies, and inefficiencies resulting from bureaucratic layering. Van Riper sees this as a very positive move and encourages scientists and managers to use the opportunity to be candid and solution-oriented in the upcoming effort. This midcourse correction exercise may be very helpful. *Van Riper can be reached at (602)556-7466.*

REGIONAL CHIEF SCIENTISTS

Anderson, William H.
NATIONAL CAPITAL
1100 Ohio Drive, SW
Washington, DC 20242
8 (202) 342-1443

Kimball, Suzette
SOUTHEAST
75 Spring St. SW
Atlanta, GA 30303
8-341-5916/404331-4916

Foley, Mary
NORTH ATLANTIC
15 State St.
Boston, MA 02109
(617) 742-3094
FAX: (617)367-8515

Hiebert, Ron
MIDWEST
1709 Jackson St.
Omaha, NE 68102
8-864-3438/(402)221-3438

Huff, Dan
ROCKY MOUNTAIN
P.O. Box 25827
Denver, CO 80225
8-327-2650/(303)969-2650

Karish, John F.
MID-ATLANTIC
Ferguson Bldg, Room 209-B
Pennsylvania State Univ.
University Park, PA 16802
8-(814)865-7974

Kilgore, Bruce
WESTERN
600 Harrison St., Suite 600
San Francisco, CA 94107-1372
8-484-3955/(415)744-3955

Kunkle, Sam
SOUTHWEST
P.O. Box 728
Santa Fe, NM 87501
8-476-6870/(505)988-6870

Jope, Kathy (acting)
PACIFIC NORTHWEST
909 1st Ave.
Seattle, WA 98104-1060
(206)220-4098

Deschu , Nancy (acting)
ALASKA
2525 Gambell St., Room 107
Anchorage, AK 99503-2892
8-869-2568/(907)257-2568

Cooperative Research on Glacier-Climate Relationships Begins in the Pacific Northwest

Humes Glacier on the heavily glaciated Mt. Olympus, Olympic NP, Washington

At least 800 glaciers occur in the greater Pacific Northwest, extending from the Pacific Ocean to the Rocky Mountains, between the Columbia River and the Canadian border. This concentration of ice is the largest in the conterminous United States, and crosses a gradient from maritime to continental climate.

Glaciers exist in the Pacific Northwest because winter precipitation often exceeds summer melt, even at relatively low elevations. They are sensitive indicators of climate change due to their size which reflects winter snow accumulation and summer temperature. Melting of glaciers in response to changing climate will have substantial consequences for river hydrology, particularly increasing flow-rate in the short-term and altering seasonality of flow in the long-term. Glacial melt could also result in greater incidence of geologic hazards. These changes will affect vegetation and animal habitat, as well as have economic consequences.

Although the size of glaciers is dependent on climate, defining the precise relationship is difficult. Describing the climate experienced by the glacier is complicated by the lack of local weather records. Detection of changes due to short-term weather trends may be difficult because effects may be obscured by the flow dynamics of glaciers. Finally, there are few long-term records of annual changes in glaciers to compare with climate records. However, these difficulties are not insurmountable, especially if the expertise of researchers from many fields is combined.

Personnel from NPS (some now with NBS) and USGS have been cooperating informally to obtain histories of the glaciers of the Pacific Northwest. Supported by the NBS Global Change Program, the agencies held a workshop entitled Glacier-Climate Relationships on May 17-18, to develop a coordinated glacier-climate research project. Numerous federal agencies, including the NPS, NBS, USGS, and National Weather Service sent representatives. Glacial resource national parks from the Pacific Northwest, including Olympic, Mount Rainier, North Cascades, and Glacier, as well as Denali, Alaska, also sent staff.

Presentations by participants showed that glaciers throughout the region are currently in retreat, although some glaciers in maritime climates had a period of advance in the 1970s and 1980s. Glaciers now experiencing a continental climate are merely remnants. Climatologists and glaciologists described the available climate models and several approaches to linking glaciers with climate. These participants identified the most valuable variables to collect from historic glacier size records. Finally, the group designed a four-stage research project to study glacier response to climate in the Pacific Northwest. They are currently seeking funding for this project.

For more information, contact Andrea Woodward, College of Forest Resources/CPSU AR-10, University of Washington, Seattle, WA 98195, (206) 685-4448, fax (206) 543-3245.

Natural Resource Publications: A Resource of Products and People

By Donna O'Leary

Interested in the complexities of reintroducing an extirpated wildlife species? Considering alternatives for dealing with a difficult wildlife issue? Need to prioritize threats from exotic plant species before targeting funds and personnel? The answers to these and many other typical resource management concerns can be found in publications of the NPS Natural Resources Publication Program, available through the NPS Natural Resources Publication Office (NRPO) in Denver, Colorado.

Since 1989, this publication program has provided guidance for managing the publication of natural resource information, specifically information disseminated through the national *Park Science* bulletins, the Scientific Monographs and Proceedings series, the Technical and Natural Resources Report series, the annual Science Report series, and the regional report series. The national publications address natural resource topics that are of interest and applicability to a broad readership that includes the NPS, others charged with managing natural resources, the scientific community, the public, and the conservation and environmental constituencies; the regional series address issues of regional interest. Each has its niche--purpose, readership, content, review--and is associated with a variety of NPS professionals who have roles and responsibilities in managing the publication of natural resource information.

The Natural Resources Publication Advisory Board advises the Associate Director, Natural Resources, the regional chief scientists, and chiefs of resource management on policy, procedures, and standards for managing the publication of natural resource information through the national and regional series. This board meets yearly to discuss publication issues and make recommendations relevant to the national and regional series (see sidebar).

Park Science, under the editorship of Jean Matthews for 14 years, grew from a regional bulletin of the Pacific Northwest Region (PNR) to a national and international bulletin that includes the widest readership of any natural resource publication. The *Park Science* Editorial Board reviews proposed articles and editorials for technical credibility and management applicability and gives appropriate consideration to NPS policy and sensitive topics. The board consists of NPS professionals with technical credentials that represent a wide range of scientific and resource management expertise and knowledge of NPS issues. Jim Larson, Chief Scientist, PNR, retired in May and has handed over the chairmanship of this board to Ron Hiebert, Chief Scientist, Midwest Region (MWR).

The prestigious Scientific Monographs (formerly the Fauna of the National Parks Series of the 1930s) and the Scientific Proceedings, the only NPS peer-reviewed series for natural resource research, offer scientists an alternative to publish longer and more comprehensive research of scholarly quality in-house. Under an NPS-Fish and Wildlife Service (USFWS) interagency agreement since 1992, and a continuing partnership with the NBS, wildlife biologist Dr. Paul Vohs edits, reviews, and manages both series. Formerly with the FWS, but "adopted" by the NPS, Vohs serves as the senior editor, with the support of the technical publication editor and editorial assistant. This fine editorial team has produced nine publications(see sidebar for a list of titles) and will con-

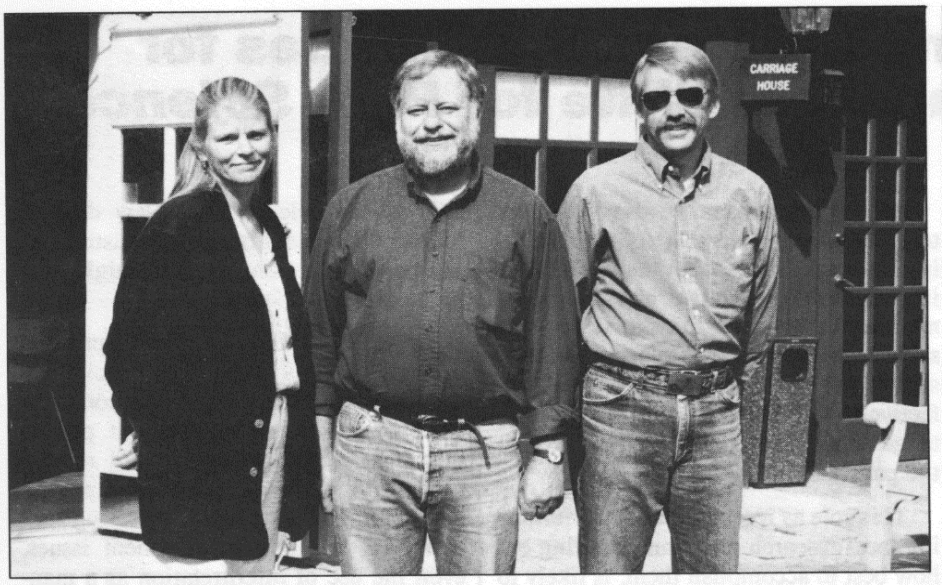
Recommendations of the Board

Meeting on May 10-11 in Albuquerque, NM, the advisory board focused on forming policy in regards to extending services to former NPS scientists that are now with the NBS. They also began developing strategies to encourage resource managers to publish more in the natural resource series.

Recommendations included retaining the Scientific Monographs and Proceedings series at this time in the NPS; allowing former NPS scientists to continue submitting manuscripts to the natural resource series; continuing to fund reprint charges for former NPS scientists; continuing regional funding of a portion of *Park Science* to ensure that "ownership" of the bulletin remains in the field; and continuing the NPS regional natural resource series--some are now managed by former NPS scientists.

Natural Resources Publication Advisory Board

(front row left to right) Gary Sullivan, MWR; Jean Matthews, PNR; Donna O'Leary, NRPO; Jeff Selleck, NRPO; (back row) Dr. Charles van Riper, III, Northern Arizona University, NBS; Dr. R. Gerald Wright, University of ID, NBS; Dr. Milford Fletcher, University of NM, NPS; and Robert Cook, Gateway NRA.



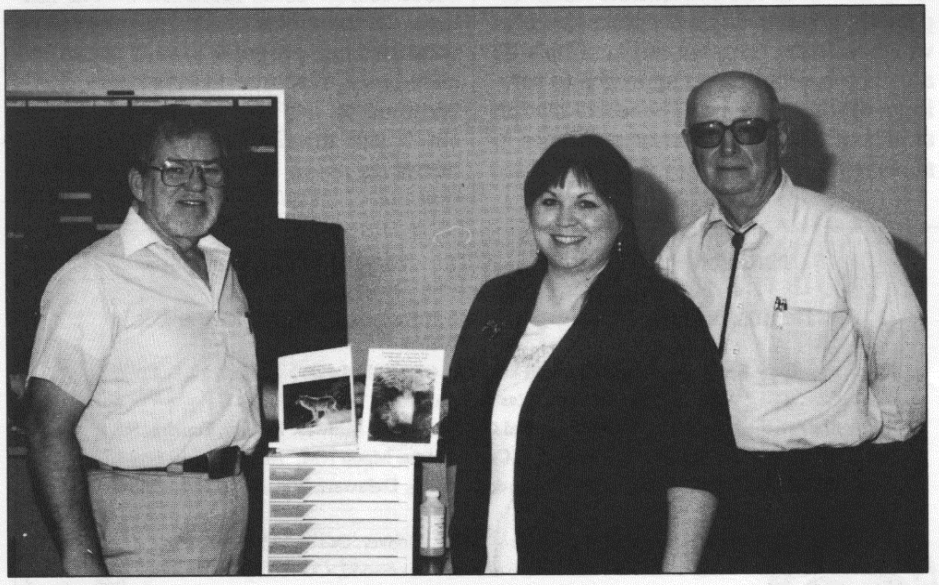
***Park Science* editorial board**
(left to right) Elizabeth Johnson, Delaware Water Gap NRA; Ron Hiebert (Chairman), Midwest Regional Office; and Jon Jarvis, Craters of the Moon, NM. Absent are Gary Davis, Channel Islands NP and John Dennis, Washington office.

tinue to produce the Monographs and Proceedings and manuscripts submitted by former NPS scientists to NBS series.

The Technical Reports disseminate technical information that addresses management issues, such as research results, inventories and monitoring activities, literature reviews, bibliographies, and proceedings of technical conferences that are not peer-reviewed. Natural Resources Reports contain information on technologies and resource management techniques, "how to" resource management papers, conference proceedings, and prototypes of programs and resource actions plans.

The yearly *Highlights of Natural Resources Management* report, edited by Lissa Fox, is produced through this series. I serve as the managing editor of both series (a new listing of titles along will be published in the winter issue of *Park Science*).

Finally, the annual Science Report lists the research projects and related studies ongoing or completed in a calendar year. The managing editor of these reports for the past seven years, Anne Frondorf, is now with the NBS. That editorship has been turned over to Tim Goddard, Wildlife and Vegetation Division.



Monographs and Proceedings editorial team
(left to right) Jerry Cox and Martha Nichols, NPS, and Dr. Paul Vohs, NBS.

O'Leary serves as publications coordinator for the Natural Resources Publication Office. As program manager, she coordinates all aspects of publishing the national series, consults with series authors, administers the planning, review, and compliance processes, facilitates the activities of the editorial and advisory boards, and oversees the partnership with the NBS. She also maintains a complete listing of available natural resource publications and can be reached at P.O. Box 25287, Denver, CO 80225-0287.

Available Monographs and Proceedings

1. **Ecological effects of the Lawn Lake flood of 1982, Rocky Mountain National Park. H.E. McCutchen, R. Herrmann, and D.R. Stevens, editors.**
2. **Ecological issues on reintroducing wolves Into Yellowstone National Park. R.S. Cook, editor.**
3. **Demography of grizzly bears in relation to hunting and mining development in northwestern Alaska. W.B. Ballard, L.A. Ayres, D.J. Reed, S.G. Fancy, and K. Faulkner.**
4. **Proceedings of fourth conference on research in California's national parks. S.D. Veirs, Jr., T.J. Stohlgren, C. Schonewald-Cox, editors.**
5. **Proceedings of first biennial conference on research in Colorado Plateau national parks. P. Rowlands, C. van Riper, III, and M. Sogge, editors.**
6. **Ecology and management of ticks and Lyme disease at Fire Island National Seashore and selected eastern national parks. H.S. Ginsberg.**
7. **Mammals of Indiana Dunes National Lakeshore. J. Whitaker, Jr., J. Gibble, and E. Kjellmark. ***
8. **Mountain goats in Olympic National Park: biology and management of an introduced ungulate. D.B. Houston, E.G. Schreiner, and B.B. Moorhead. ***
9. **Proceedings of the second biennial conference on research in Colorado Plateau national parks. C. van Riper, III, editor. ***

*** Available first quarter of FY95.**

Changes Bring Greater Opportunities for Resource Managers to Write for *Park Science*

By the editor

At a time of great change for the resource management and science programs of the National Park Service, I foresee a need to develop a cadre of *Park Science* contributors primarily from among the resource management ranks. The establishment of the NBS, the proposed combination of natural and cultural resources under one associate director for resource stewardship, streamlining, and the continuing professionalization of resource management challenge us to improve our skills, work more effectively, develop ourselves as leaders, and refine the role of resource management and science in the parks. In order for *Park Science* to continue its relevance and usefulness, we must look to our resource managers to become principal writers for this publication to keep apace with these developments.

The transfer of our scientists to the National Biological Survey has had great ramifications for the role of resource management and will probably begin to affect the numbers and kinds of articles that are submitted to *Park Science*. Staff scientists will no longer be the central source of material for this publication. Cooperative Park Studies Units scientists, contract researchers, and affiliated university investigators studying local questions will, of course, continue to be excellent sources for articles and assistance. To be sure, I encourage article contributions to continue from these sources and from the NBS, but also want to extend an invitation to resource managers to submit items for publication.

While we expect to be well served by the NBS, USGS, and other research organizations in meeting our research needs, resource managers may now recognize opportunities to begin filling some of the niche formerly held by our scientists. Resource managers will have to carry out monitoring protocols that, in the past, often fell to researchers. As long as good scientific design is employed and results are repeatable, resource managers may also be able to forge ahead into new areas, discovering new ways to make progress with research needs through reduction and analyses of monitoring results.

Resource managers are also beginning to coordinate the larger activity of defining the role of science for the parks. This important responsibility gives resource managers the opportunity to work with scientists to identify the most critical research questions; they must also deal effectively with regional offices and WASO to generate research initiatives through the park planning process.

This role as research broker, prioritizing local research needs and figuring out how best to accomplish them, is likely to become more important without staff scientists. Opportunities to write about these maturing roles in *Park Science* may prove both valuable and relevant as innovative approaches to research are tried, projects are completed, and professionalization of the resource management division continues.

While on a recent trip to several parks, I discovered another argument for encouraging article submissions from a broader corps of writers. Many readers perceive that contributions to *Park Science* must comprise hard research to be eligible for publication. While research is welcome, the *application* of research in implementing a local resource management project (along with its results), for example, is of equal interest and importance. Similarly, an article need not concentrate on an especially popular or timely issue, such as wolf reintroduction, but might simply do a good job detailing an approach to solving a routine problem. The recent studies at Mount Rainier on visitor responses to signs requesting that they stay on trail are a good example of this. New data or followup information about existing resource management projects might also make good articles.

In general, submissions to the publication may include natural and social science research and associated recommendations, resource management project implementation summaries and results, inventorying and monitoring updates, public affairs strategies for handling controversial resource management issues, even the use of interpretation as a management tool to involve the public in a resource management program. I suspect that we also will publish more articles (or cross reference them with the CRM) having to do with cultural resources as we move toward integrating natural and cultural resource management into a single division. As long as articles discuss the management implications of research and resource management activities they are suitable for submission to *Park Science*.

With all their variety, parks challenge us with complex and diverse resource management problems. Our response to these problems, through resource management as detailed in *Park Science*, distinguishes this publication. As we meet the challenges ahead, *Park Science* will continue to be the vehicle that tracks our successes, gives us feedback on our failures, demonstrates our effectiveness, and measures our progress toward sound science-based resource management. Let's continue to use this publication to celebrate our development and distinguish ourselves as we adapt to the big changes that are upon us.

National Park Service, U.S. Department of the Interior
Roger G. Kennedy, Director
Dennis B. Fenn, Acting Associate Director, Natural Resources

Jeff Selleck, Editor, P.O. Box 25287, Denver, CO 80225-0287
and 12795 W. Alameda Parkway, Lakewood, CO 80228;
(303) 969-2147; Fax (303) 969-2822.
ISSN-0735-9462

Contributing to *Park Science:*
Case Study and Feature Article Submission Criteria

Park Science is a quarterly, 32-page, National Park Service resource management bulletin. It explores natural and social science-based solutions to natural and cultural resource management problems in the national park system. Wide circulation facilitates the broad application of research results systemwide.

Content--The publication features articles of general interest on field-oriented research, resource management problem case studies, trends in resource management and research, professional growth opportunities, regional highlights and calendar activities, article and book reviews, and other resource stewardship information.

Focus and Tone—Material should emphasize the implications of natural or social science research for the management of natural and cultural resources. A broad readership calls for clear communication--highlight main concepts, explain methods and project significance, and detail applicability to management. Write primarily in the active voice and explain technical terms.

Target Audience and Primary Authors--Principal readers and contributors comprise national park system area superintendents, resource managers, natural and social science researchers, interpreters, maintenance staff, visitor and resource protection rangers, and other technical and nontechnical personnel. Circulation also includes other federal agencies; state departments of fish and game, parks and recreation, and natural resources; international parks; private conservation organizations; the academic community; and interested public.

Criteria--Feature articles and case studies may include (1) a description of the resource management problem(s) that prompted the research; (2) an explanation of the significance of the resource management project; (3) discussion of management considerations related to the problem(s), such as relevant legislation (enabling, NEPA, ARPA, FACA, Endangered Species Act, etc.), pertinent park planning documents (GMP, SFM, FMP, RMP, etc.), planning procedures, and political considerations; (4) a summary of the methodology of the experiment; (5) the results and recommendations of the research; (6) a description of how the findings were applied in the field; and (7) an appraisal of the scope of applicability of the findings to other park areas. As additional information about a project accrues, follow-up reports (one or more years later) may be very useful in fine tuning conclusions.

Length—Less than 1,500 words.

Deadlines—Fall issue--August 1; Winter--November 1; Spring--February 1; Summer--May 1.

Review Procedures--Prior to submission, pieces must be reviewed by the area manager (superintendent) for policy considerations, and by the regional chief scientist. The editor and editorial board ensure that submissions are technically credible, relevant, of general interest, broadly understandable, solution-oriented, applicable in the field, and in agreement with the submission criteria.

Author Information—In addition to a byline, include position title, park area or affiliation, a brief biography, work address, phone and fax numbers, and electronic mail addresses (e.g., cc:Mail or Internet).

Measurements--Report measurements in metric (using abbreviations for units) followed by English in parentheses. Time is to be reported using A.M. and P.M.

Illustrations—Submit a minimum of three illustrations in support of feature articles and case studies. Show personnel at work, project equipment, techniques used, etc., to illustrate the focus of the article. Original line art, photostats, high quality xeroxes, black and white photographic prints (glossies preferred), color prints, and either color or black and white slides are acceptable. Computer-generated illustrations (i. e. scanned art, and drawing software originals saved as .EPS, .BMP, .PCX or .TIF files) can be forwarded through cc:Mail (attach as DOS file), on floppy disc, or on laser-printer originals (600 dpi if possible). Include the name of the artist or photographer and documentation of approved use if the illustration is copyright-protected. Label each illustration with park name, article title, and any placement information (e.g., fig. 1).

Captions--Describe the relationship of the illustration to the theme of the article.

Delivery—Submit approved contributions to the editor using these methods in priority order:

(1) by cc:Mail with the word-processed document and any illustration files attached as DOS files. Indicate the word-processing software and version in the cover message (e.g., WordPerfect 5.1). Files can be compressed using PKZip if especially large.

(2) by mailing the hard copy (double-spaced) and a floppy disc containing the word-processed document (indicate the software and version) and any illustrations;

(3) by mailing the double-spaced hard copy (laser-printed originals if possible) and any illustrations alone;

(4) by fax. Use double-spaced, laser-printed originals if possible. Illustrations may not be faxed.

Questions--If you have an idea for an article, but are not sure about its usefulness, relevance, or desirability, call the editor before writing to discuss appropriateness and ideas for development. Other questions or comments are also welcome.

Contacting the Editor

Cut out this card and place it in your Rolodex . . .

Park Science

Jeff Selleck, Editor
National Park Service
Natural Resources Publication Office
Phone (303) 969-2147
Fax (303) 969-2822
cc:Mail:Selleck, Jeff;WASO-NRPO, Editor
Internet: jeff_selleck@nps.gov

U.S. Postal Service--Mail
NPS-WASO-NRPO
P.O. Box 25287
Denver, CO 80225-0287

Federal Express--Packages
NPS-WASO-NRPO
12795 W. Alameda Parkway
Lakewood, CO 80228

Delineation of Old-Growth Oak and Eastern Hemlock in Great Smoky Mountains National Park

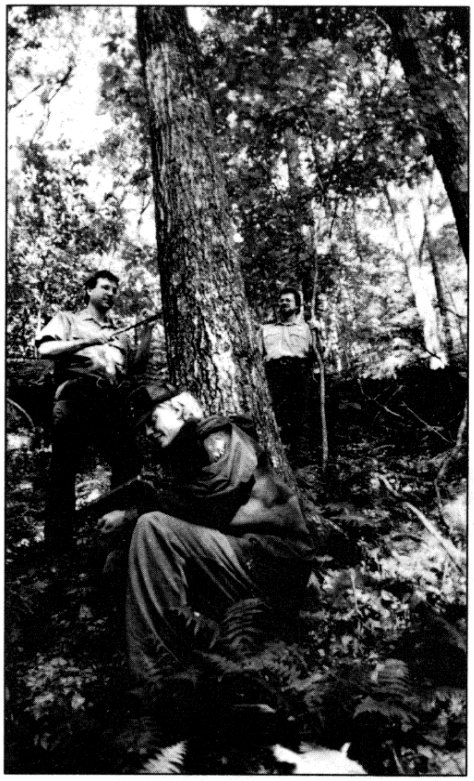
By Edward C. Yost, Katherine S. Johnson, and William F. Blozan

Editor's Note: The Great Smokies old-growth baseline data study was funded through NRPP (Natural Resources Preservation Program) monies as an inventory and monitoring project and was the first of its kind within the park.

In response to the southerly spread of two exotic forest pests, the gypsy moth (*Lymantria dispar* (L.)) and the hemlock woolly adelgid (*Adelges tsugae* Annand), Great Smoky Mountains NP, Resource Management and Science Division, initiated the Old-Growth Project to identify and map the park's old-growth oak (*Quercus* spp.) and eastern hemlock (*Tsuga canadensis* (L.) Carr.) forests and to establish long-term vegetation monitoring plots within these areas. Identification and mapping of representative stands is now complete and establishment of long-term monitoring plots is beginning.

Stand Location and Delineation

We located the old-growth hemlock and oak forests using current Geographic Information Systems (GIS) data (Pyle 1985, MacKenzie 1991) and recent aerial photography (1:12,000 scale) in conjunction with historical information, old photographs, previous vegetation studies, reports of anthropogenic disturbance, and interviews with persons knowledgeable in early pre-park history. We selected a minimum stand size of 5 hectares (ha) for hemlock; a minimum stand size was not used for oak forests due to their small size and patchy distribution (smallest delineated area equaled 2 ha). Each potential site was ground truthed and mapped. We conducted a minimum of two arbitrarily placed canopy tree tallies in each stand using approximately 1/10-ha circular areas to tally species, relative frequency, crown class, and regeneration. The tally information was used to estimate canopy dominance, species composition, and to verify forest types (see table 1 for forest type descriptions). We determined the old-growth forest type by the species or species association with the highest (minimum 50% frequency) representation in the dominant and codominant canopy classes. We took increment cores and



Researchers using increment coring tools examined 700 trees throughout the study area in order to confirm the presence of old-growth. Increment coring is a common technique for aging trees by counting growth rings.

Table 1. Description of Forest Types Used for Delineation

Mesic Oak

Within the park, these forests occur at middle to upper elevations from 1,585-1,067 m (3,500-5,200 ft) on gently sloping ridge crests with south, east, or west aspects, and at lower elevations from 763-1,372 m (2,500-1,800 ft) on nearly flat south aspects. At the higher elevations northern red oak is dominant, with canopy associates of white oak (*Quercus alba* L.), chestnut oak (*Quercus prinus* L.), red maple, eastern hemlock, and Carolina silverbell. Mesic oak forest at lower elevations is dominated by chestnut oak associated with red maple, black gum (*Nyssa sylvatica* Marsh.), pignut hickory (*Carya glabra* (P. Mill.) Sweet), and black birch (*Betula lenta* L.). In both cases, oak species comprise 50% or more of the upper canopy (per canopy tree tally). The understory community includes sweetshrub (*Calycanthus floridus* L.), maple-leaf viburnum (*Viburnum acerifolium* L.), azaleas (*Rhododendron* spp. L.), and witch-hazel (*Hamamelis virginiana* L.).

Submesic Oak

These forests occur on moderate middle elevation 763-1,372 m (2,500-4,500 ft) slopes, with southerly aspects or on nearly flat north-facing ridge tops in the western end of the park. These ecosystems are dominated by chestnut oak, northern red oak, and red maple, and oak species comprise 50% or more of the upper canopy layers (per tree tally). The understory is dominated by deciduous ericads—primarily huckleberries (*Gaylussacia* spp. Kunth), blueberries (*Vaccinium* L.), and azaleas.

Subxeric Oak

These forests are dominated by chestnut oak, scarlet oak (*Quercus coccinea* Muenchh.), and black oak (*Quercus velutina* Lam.), which comprise 50% or more of the upper canopy (per tree tally). Pines (*Pinus* spp. L.) often mix with the hardwoods. The understory component is primarily mountain laurel (*Kalmia* spp. L.), with other ericads such as blueberries, huckleberries, and rhododendron (*Rhododendron* spp. L.).

Xeric Oak

Blackjack (*Quercus marilandica* Muenchh.), scarlet, and chestnut oaks are common on these dry, often south-facing areas. Oak species represent 50% or more of the upper canopy. Virginia pine (*Pinus virginiana* P. Mill), pitch pine (*Pinus rigida* P. Mill), and Table Mountain pine (*Pinus echinata* P. Mill) often share the canopy, along with sourwood (*Oxydendrum arboreum* (L.) DC.), black gum, and red maple. Blueberries and mountain laurel generally occupy the shrub layers.

Hemlock/Cove Hardwoods

These forests generally occur on moist, north-facing slopes to about 1,219 m (4,000 ft) in elevation. Hemlock dominates the upper canopy, and hardwood associates include tulip-poplar, black birch, yellow birch, and Fraser magnolia. The understory is typically dense rosebay rhododendron (*Rhododendron maximum* L.) and dog-hobble (*Leucothoe* spp. D. Don).

diameters at breast height from a minimum of two trees per tally site, and noted old-growth characteristics and anthropogenic disturbance (see tables 2 and 3 for criteria). Additional increment core data—taken on the location of potential old-growth stands and in areas of suspected disturbance—were essential for verifying tree ages and releases in annual growth. We considered a minimum age of 150 years a coarse filter for old-growth candidacy, as the lower valleys were cleared for agriculture and timber as early as 1840 (Trout 1987).

Results and Discussion

We located and mapped 86 stands, totalling 926 ha, as summarized by forest type in table 4. The stands were distributed throughout the park, although oak types tended to be concentrated in the western portion and hemlock types in the eastern portion. In general, the hemlock stands represented relatively undisturbed areas; oak areas exhibited a higher level of disturbance, especially due to the loss of the American chestnut (*Castanea dentata* (Marsh) Borkh.). With the exception of xeric oak, we located representative stands in all of the oak and hemlock forest types considered in this project, although we delineated only one small (2 ha) stand in subxeric oak. In the remaining forest types—mesic oak, submesic oak, hemlock/northern hardwoods, and hemlock/cove hardwoods—stands with both high and moderate virgin forest attribute ratings were delineated and are available for permanent plot location.

Technique

Hardwood forest types of the eastern and southern United States are highly variable (Avery 1978), and infrared aerial photo interpretation of old-growth forests proved difficult within our study area. We did not determine a reliable, consistent photo identification pattern of forest types, due in part to the seasonal differences in photo sets and the wide range of color variation between prints on the same flight line. Images at the edges of stereo pairs were inherently distorted and hemlock canopy dominance was visually exaggerated within these areas. In contrast with hemlock, old-growth oak in our project areas could not be reliably determined by photo characteristics. For example, areas with old-growth characteristics such as large flat-topped crowns were generally younger (60-120 years), than vigorous northern red oaks (*Quercus rubra* L.) or second-growth forest. Areas on the photos that appeared as canopy gaps were often rocky areas, cliffs, or steep changes in elevation, and could not be considered indicators of old-growth based solely on the photo image.

Initially, we used a composite GIS map of areas lacking known human disturbance (Pyle 1985) overlaid with predicted forest cover types (MacKenzie 1991) to locate old-growth oak. Ground truthing revealed that oak forest type predictions were fairly accurate but that human disturbance records were not consistently reliable. Old-growth mesic oak was particularly over-predicted, and submesic oak was often of old-growth character inside and outside the predicted areas.

Experience in each forest type has led us to realize that one old-growth characteristics rating system is not applicable to all forests in the park, and forest type-specific rating methods need to be developed. As an example, attributes that were rated higher in our mesic oak forests, such as pit-and-mound microtopography, were rated lower in submesic stands where the trees typically rot and decay without uprooting. The lower rating was not due to a lack of old-growth integrity but perhaps to a difference in soils and windthrow characteristics. Modifications might include quantifying each old-growth attribute or "weighing" human disturbance more heavily than other attributes.

The 150-year-minimum age for old-growth—intended to "filter out" most European influence in the park—tended to exclude old-growth ecosystems with a severe or regular disturbance regime because they lacked the project's old-growth characteristics, such as consistent "old" ages and uneven-aged structure. In addition, "virgin" forests recovering from extensive disturbances, including wind and ice storms, chestnut blight, or forest fires could have been excluded if the disturbance occurred after the 1840s.

Continued on page 16

Table 2

Old-growth Characteristics

Listed attributes rated in all forest types except oak specific (++) and hemlock specific (*).

- •Logs in all stages of decomposition
- •Standing snags
- •Majority of canopy tree ages 150 years or greater
- •Canpoy gaps (log present in some stage of decay)
- •Little evidence of human disturbance
- •Pit and mound microtopography
- •High amount of woody debris on ground and in associated streams
- •Old bark characteristics of canopy trees
- •Bole and root decay
- •Canopy structure multilayered (uneven-aged or in a series of age classes ++)
- •Flat-topped tree crowns ++
- •Undisturbed soil *
- •Uneven-aged structure *
- •Large trees (relative to site) *
- •Large commercially important tree species of high quality *
- •Rounded tree crowns in profile *

Table 3

Disturbance Rating Classes

High in virgin forest attributes (A): the stand retained natural structure with little or no record or evidence of human disturbance.

Moderate in virgin forest attributes (B): the stand generally retained natural structure with record of evidence of selective logging or chestnut blight.

Low in virgin forest attributes (C): the stand retained scattered old-growth trees with record or evidence of extensive disturbance due to logging or chestnut blight.

Adapted from Pyle 1985.

Table 4

Delineated Area Totals by Forest Type

Total survey area: 959 ha*

	Oak Types (665 ha)			Hemlock Types (294 ha)	
	Mesic	Submesic	Subxeric	Hem/Cove	Hem/North
Total ha per type	212	451	2	247	47
# stands surveyed	21	39	1	19	6
Avg. stand size	10	12	2	14	8
% Total	22	47	0.2	26	5

*Areas displayed in this table are not adjusted to scale for slope.

Table 5

Forest Type Comparisons Based on Canopy Tree Tallies

Hemlock Type:	Hemlock/Cove			Hemlock/North		
Species	Comp%		Canopy%	Comp%		Canopy%
Betula alleghaniensis	6.4		4.9	8.6		3.6
Acer rubrum	3.7		3.9	3.9		3.6
Magnolia fraseri	2.8		2.3	8.9		1.5
Oak Type:	mesic	submesic	subxeric	mesic	submesic	subxeric
Species	% Composition			% Upper Canopy		
Quercus rubra	30.0	14.6	0.9	50.6	20.0	2.0
Quercus prinus	4.0	22.6	23.4	7.7	34.9	31.4
Quercus velutina	0.1	3.1	8.1	0.2	3.9	5.9
Quercus coccinea	0.4	2.0	14.4	1.1	3.1	27.5
Quercus spp. total	40.8	49.1	54.0	67.7	72.8	82.4

Through the collection of 748 complete (readable, to center, and lacking rot) core samples, we determined that bark characteristics did not always indicate relative age. For both hemlock and oak, old (exceeding 150 years) suppressed trees had "young" bark characteristics, and young vigorous trees had the very rough and furrowed bark usually associated with old trees. In addition, we found some species with atypical bark characteristics, and some species such as American beech (*Faqus qrandifolia* Ehrh.), Fraser magnolia (*Maqnolia fraseri* Walt.), and American holly (*Ilex opaca* Ait.) may never develop rough bark.

Tree Tally Information Summary

The following information is based on arbitrarily placed canopy tree tally areas and should be considered preliminary; data from the permanent monitoring plots will be necessary to substantiate or refine these observations.

Two types of eastern hemlock forests were surveyed in this project: Hemlock-Cove hardwoods and Hemlock-Northern hardwoods. Within our study area, preliminary information suggests considerable compositional differences between the two types (table 5). Some patterns, however, appeared common to both forest types. Species such as Fraser magnolia, yellow birch (*Betula alleghaniensis* Britt.), and silverbell (*Halesia tetraptera* var. monticola Ellis) had a low recruitment to the upper canopy, based on their total compositional value. In contrast, red maple (*Acer rubrum* L.) was relatively even in distribution throughout the canopy. Hemlock was more frequent in the suppressed canopy class, which may indicate that suppressed hemlock saplings were distributed evenly throughout the lower canopy (therefore, well represented in the tally data), whereas suppressed hardwoods were only well represented in scattered canopy gaps. In both types, hardwoods dominated the intermediate canopy class.

We differentiated three types of oak forests based on overall canopy composition related to exposure and elevation (Whittaker 1956). Oak dominated all types and varied considerably in composition as well as in the canopy distribution of species in each. Oak increased in compositional value as a component of the forest as a whole and within upper canopy layers as aspects became more exposed and better drained. Overall, oaks (aside from northern red) increased in composition from mesic to subxeric sites.

Summary

Currently, 959 ha of old-growth oak and hemlock stands are delineated in the Smokies, and permanent monitoring plots will continue to be established through the 1994 field season. The baseline data will provide information for the definition and understanding of these ecosystems, and are valuable as a preinfestation reference for future pest management decisions.

Yost, Johnson, and Blozan are NPS forestry technicians at Great Smoky Mountains National Park, 107 Park Headquarters Road, Gatlinburg, TN 37738, (615) 436-1707

References Cited

Avery, E.A. 1978. *Forester's Guide to Aerial Photo Interpretation.* U.S. Forest Service Agriculture Handbook No. 308.

Carbonneau, L.E. 1986. Old-growth forest stands in New Hampshire: a preliminary investigation. Master's thesis, University of New Hampshire, Durham.

Eyre, F.H. 1980. Forest Cover Types of the United States and Canada. *Society of American Foresters.* Washington, D.C.

MacKenzie, M.D. 1991. *Vegetation map of the Great Smoky Mountains National Park based on Landsat Thematic Mapper Data: accuracy assessment and numerical description of vegetation types.* University of Wisconsin, Madison.

McCarthy, B.C. 1991. Ecology of old-growth forests. In *Department of Biology, Proceedings of Faculty Lecture Series.* Frostburg State University, Frostburg, MD.

McLeod, D. 1992. Attributes of old-growth mixed mesophytic forests in the Southern Appalachians. In *Proceedings of the Southern Appalachian Man and Biosphere Conference.* Gatlinburg, TN.

Miller, F.H. 1938. Brief narrative descriptions of the vegetative types in the Great Smoky Mountains National Park. Report to the Superintendent. National Park Service, Great Smoky Mountains National Park Library, Gatlinburg, TN.

Nowacki, G.J. 1991. Old-growth characteristics list. In *Proceedings from the Old-Growth Characteristics and Methods of Inventory Workshop. Nantahala/Pisgah Land and Resource Management Plan Re-analysis.* U.S. Forest Service, Asheville, NC.

Pyle, C. 1985. Vegetation disturbance of the Great Smoky Mountains National Park: an analysis of archival maps and records. Research/Resources Management Report SER 77. National Park Service, Southeast Region, Atlanta, GA.

Trout, E. 1987. Logging in Sevier County, Tennessee. National Park Service Report, National Park Service, Great Smoky Mountains National Park Library. Gatlinburg, TN.

Whittaker, R.H. 1956. Vegetation of the Great Smoky Mountains. *Ecological Monographs* 26(1):1-80.

Whitney, G.G. 1987. Some reflections on the value of old-growth: scientific and otherwise. *Natural Areas Journal* 7(3):92-99.

Keeping Visitors On The Right Track:
Sign and Barrier Research at Mount Rainier

By Thomas C. Swearingen and Darryll R. Johnson

***Editor's Note**: This is the third report by the authors on noncompliant visitor behavior at Mount Rainier.*

Paradise Meadows is one of the most popular and accessible areas in Mount Rainier NP (MORA). Thousands of park visitors stop at Paradise Meadows each day during peak season to hike, eat, view the mountain, and tour the visitor center. Off-trail hiking is a major source of human impact that creates social trails and related erosion throughout the several thousand acres of subalpine meadows. With up to 5,000 visits a day, even a small proportion of visitors leaving established trails and deviating onto the meadows has a significant adverse impact. Managers at Paradise Meadows need data on the effect of various control strategies to protect the environment from inappropriate and destructive behavior.

Since off-trail hiking can cause severe damage to fragile natural environments, trailside signs, barriers, and other visitor control techniques represent the last opportunity for resource managers to deter inappropriate activities in such locations. To test the effectiveness of such strategies, the University of Washington Cooperative Park Studies Unit administered several experiments at Paradise Meadows. These experiments are presented as a case study in the applications of social science methods to natural resource management.

METHODS

The research at MORA assessed the efficacy of alternative trailside sign texts, barrier types, and uniformed personnel in deterring off-trail hiking. Altogether, we studied the behavior of 17,416 visitors at three sites in the meadow in an experiment designed to compare the effectiveness of six different types of signs. Throughout each observation day, researchers systematically rotated all experimental signs at each site to control for bias due to lack of randomization. Constructed of a standard engraved brushed metal and bolted onto brown steel posts, the signs were positioned about knee high along the trail. The topography of the meadows and the position of the signs made it difficult to pass the experimental sites and fail to see the signs (see sidebar for a description of the experimental sign contents).

Experimental Signs

The experiment design used one stake, six sign treatments, and a control (no sign). The signs read: (1) "No Hiking - Meadow Repairs" (the standard NPS meadow sign), (2) "Stay On The Paved Trails And Preserve The Meadow" (new preservation appeal sign), (3) international red circle/crosshatch sign with a hiker's profile (symbolic sign), (4) "No Off-Trail Hiking"--combination of a prohibitory message with the same hiker symbol--(hybrid), (5) "Off-Trail Hikers May Be Fined" (threatened sanction), (6) short stake (approximately ½m or 1½ ft high) with a small version of the symbolic sign (stake), (7) "DO NOT TREAD, MOSEY, HOP, TRAMPLE, STEP, PLOD, TIPTOE, TROT, TRAIPSE, MEANDER, CREEP, PRANCE, AMBLE, JOG, TRUDGE, MARCH, STOMP, TODDLE, JUMP, STUMBLE, TROD, SPRINT, OR WALK ON THE PLANTS" (humorous sign), and (8) control (no sign).

At one site, each experimental sign was alternately displayed either once at the behavior observation site or several times along the trail leading up to the observation site. Researchers collected data on the behavior of subjects exposed to the experimental signs (preservation appeal, symbolic, hybrid, sanction, and humorous signs). We designed this procedure to determine if the initial effect of a novel sign would be different from repeated exposure to that sign as the novelty diminished.

At a different experiment site, a uniformed NPS employee was alternately present and absent through entire sign treatment rotations on random days. The female employee wore a class A field uniform with green jeans or shorts, a NPS short sleeve shirt, and a forest green NPS baseball cap. She did not wear the class A dress uniform with a more military or authoritarian appearance. The employee did not approach visitors to enforce rules, but was clearly visible along the trail at the experimental sign site during the appropriate data collection periods.

In another component of the study, a barrier experiment included behavioral data on 6,006 subjects at three sites. At these sites, we studied the effect of two types of trailside barriers. The experiment consisted of systematic rotation of (1) a split rail fence, (2) a yellow polypropylene rope supported by lathe posts placed at knee height (approximately), and (3) a control (no barrier). Due to the more permanent nature of barriers, each was erected on each site for several days.

Trained personnel observed visitors from unobtrusive sites, and visitors could not infer that they were under observation. Data were recorded on standardized observation sheets, and additional qualitative comments and observations were logged into daily journals. Data described each participant, group, and compliant or noncompliant behavior in the presence of the signs or barriers, and the behavior of other parties in close visual proximity. We defined noncompliance as off-trail hiking where the subjects deviated off the trail in the immediate proximity of the signs or barriers.

RESULTS

The Sign Experiment

The sign experiment results indicate that trailside signs significantly reduce off-trail hiking in comparison to no sign (a control). In comparisons between signs, each sign was statistically compared to the next most effective sign in a step-wise procedure to determine how the effective signs might be grouped.

Different signs varied significantly in observed rates of noncompliance (table 1). The threatened sanction sign was more effective than the next best treatment, the new preservation appeal (chi square = 10.0, p= .0016), and reduced off-trail hiking by 75% in comparison to the control. The next four most effective signs (new preservation appeal, humorous, hybrid, symbolic) were not significantly different. However, the symbolic sign was not significantly more effective than the old standard sign. Thus, the new preservation appeal, humorous, and hybrid signs represent middle-range effectiveness. The old standard and the symbolic signs are a third range of effectiveness, and the old standard "Meadow Repairs" sign is the least effective. Off-trail hiking rates did not

Continued on page 18

differ significantly from the control (chi square = 3.3, p = .0684) when visitors were exposed to the stake.

The research also addressed the potential for a novelty effect on hiker behavior of the presence of unusual signs placed singularly or repeatedly on the trailside. We investigated whether repeated exposure to an unusual, novel sign causes a change in the effectiveness of the unusual sign type. Data analysis revealed that there was not a significant difference in compliance rates when the repeated preservation appeal, symbolic, or sanction signs were present or absent. There was, however, a significant difference in compliance rates between single and repeated exposures to the hybrid sign; off-trail hiking increased [this is surprising] when the sign was present several times along the trail corridor.

Characteristics of Off-trail Hikers

At experimental sites, the majority (58%) of all off-trail hikers were white adults. However, a disproportionate number were non-white (a large percentage of whom were foreign). Some Asian tour groups were even observed being led off-trail by their tour leaders. Although adults accounted for 58% of all noncompliant behavior, analysis of the data indicated that teens and children were more likely to deviate off-trail.

The majority of off-trail travel (78%) occurred when other parties in the vicinity of the party under observation stayed on the trails. However, the probability of off-trail hiking increased when the offending hikers could view noncompliance by others in their general vicinity. Finally, when the observed noncompliance occurred among a group of visitors, a large proportion or all of the group was likely to walk off-trail.

The Barrier Experiment

The data from the barrier experiment sites are presented in table 2. The yellow polypropylene rope barrier was significantly more effective in deterring off-trail hiking than the split rail fence. On average, ropes were over twice as effective as split rail fences in reducing noncompliance. Both barriers significantly reduced off-trail hiking in comparison to no barrier (the control).

Uniformed Personnel

Noncompliance almost disappeared in the presence of the uniformed employee (table 3). Interestingly, additional analyses revealed that the positive effect of signs remained evident; that is, signs still had a significant, although slight, deterrent effect on off-trail hiking in the presence of the uniformed person.

Management Implications

The statistical analyses indicate that the threatened sanction sign is the most effective. Indeed, the next most effective sign (preservation appeal) had a noncompliance rate nearly twice as

Table 1

Sign Text by Visitor Compliance
Mount Rainier Sign Study

Sign Text	Compliance Status[1] C	NC	Row Totals
Sanction (Row)	98.3%	1.7%	100%
(Column)	13.8%	5.5%	13.5%
(Count)	1957	33	1990
Preservation Appeal	96.7%	3.3%	100.0%
	11.3%	9.2%	11.2%
	1596	55	1651
Humorous	96.6%	3.4%	100.0%
	11.3%	9.5%	11.3%
	1607	57	1664
Hybrid	96.4%	3.6%	100.0%
	14.8%	13.0%	14.7%
	2095	78	2173
Symbolic	95.9%	4.1%	100.0%
	15.2%	15.3%	15.2%
	2155	92	2247
Old NPS Standard	95.1%	4.9%	100.0%
	13.0%	15.7%	13.1%
	1837	94	1931
Stake	94.7%	5.3%	100.0%
	9.8%	12.8%	9.9%
	1386	77	1463
Control (no sign)	93.1%	6.9%	100.0%
	10.9%	19.0%	11.2%
	1539	114	1653
Column Totals	95.9%	4.1%	100.0%
	100.0%	100.0%	100.0%
	14172	600	14772

Missing Cases = 0
Chi-Square = 77.5, p = .0000
Cramer's V = .07

[1]C = Complier NC = Noncomplier

Table 2

Barrier Type by Visitor Compliance
Mount Rainier Barrier Study

Barrier Type	Compliance Status[1] C	NC	Row Totals
Rope (Row)	97.9%	2.1%	100%
(Column)	22.3%	8.0%	21.5%
(Count)	759	16	775
Split Rail	95.1%	4.9%	100.0%
	49.5%	43.7%	49.1%
	1682	87	1769
Control	90.9%	9.1%	100.0%
	28.2%	48.2%	29.3%
	960	96	1056
Column Totals	94.5%	5.5%	100.0%
	100.0%	100.0%	100.0%
	3401	199	3600

Missing Cases = 0
Chi-Square = 44.7, p = .0000
Cramer's V = .11

[1]C = Complier NC = Noncomplier

high as the sanction sign. A cluster of signs of nearly equal effect, including the preservation appeal, humorous, and hybrid signs, follow the sanction sign. All remaining signs were either significantly less effective (symbolic and old standard signs) or essentially ineffective (stake).

We did not assess the effect of the sanction sign on the visitor experience. Thus, this sign should be used with caution and only when adverse environmental impacts dictate stringent measures. Other less intrusive signs may suffice to reduce visitor impacts in many circumstances.

There does not appear to be a novelty effect related to the unfamiliar, experimental signs; they worked equally well as a deterrent to off-trail hiking in multiple or single exposures. However, there was some indication of a novelty effect specific to the hybrid sign.

The effect of the presence of a uniformed employee suggests that off-trail hikers are not ignorant of agency expectations regarding appropriate behavior. Evidently, a uniformed park employee in the immediate vicinity of a sensitive area will greatly reduce noncompliant behavior. Without further research, we do not understand the psychological basis for the effectiveness of the uniformed employee. It appears, however, to be one of the most effective deterrents.

The use of both barrier types improved visitor cooperation. Even the least effective barrier (split rail) proved advantageous, as 46% less noncompliance was observed in its presence in comparison to the control (no barrier). At a third site (data not presented), the rope barrier also reduced off-trail hiking at a popular snow play area, but noncompliance remained very high. Although not directly compared to the signs in this study, rope barriers may not be more effective than threatened sanction signs in deterring off-trail hiking.

Table 3

Uniform Presence by Visitor Compliance Mount Rainier Barrier Study

Treatment	Compliance	Status[1]	Row Totals
	C	NC	
Uniform Present			
(Row)	99.4%	0.6%	100.0%
(Column)	33.0%	10.8%	32.6%
(Count)	2522	16	2538
Uniform Absent	97.5%	2.5%	100.0%
	66.1%	88.6%	67.4%
	5123	132	5255
Column Totals	98.1%	1.9%	100.0%
	100.0%	100.0%	100.0%
	7645	148	7899
Missing Cases = 32			
Chi-Square = 32.2	p = .0000		
Cramer's V = .065			

[1]C = Complier NC = Noncomplier

Vandalism and littering literature consistently suggests that "vandalism [littering] begets more vandalism [littering]." A similar pattern of behavior was also observed in relation to off-trail hiking. Furthermore, when noncompliance occurred within a party, it often involved a large proportion of the group, indicating a likely peer effect relating to noncompliant behavior.

Both youths and foreign visitors disproportionately engaged in off-trail hiking. Perhaps specific communications could be directed toward these visitor subpopulations. However, the primary visitor management strategies must concentrate on the majority of the off-trail hikers--white adults.

CONCLUSIONS

The Mount Rainier study tested the effectiveness of selected social control techniques designed to deter off-trail hiking. Such behavior can cause immense damage, both environmentally and aesthetically, and this problem has been noted in most outdoor recreation areas. Furthermore, the park efforts at rehabilitation of the resources (e.g., high standard trails and meadow restoration) can only be effective if the continuing problem of human impact is also contained.

The park has attempted to influence visitor behavior with naturalist programs and passive communications which emphasize the importance of low impact use of the area and appreciation of nature. An implicit assumption of this strategy is that noncompliant visitor behavior (e.g., off-trail hiking) is caused by a lack of knowledge about, or appreciation for, proper use of the resource. The objective of this communication approach is to motivate behavior by creating a pro-social psychological state in which recreationists view behavior desired by park managers as satisfying personally desired goals.

Exposure to a message does not ensure that it will be accepted or understood by all people, and many other visitors may never see or hear the messages. Some proportion of park visitors will always be unaffected by even the best communication strategies. In these circumstances, the last chance to influence undesirable behavior of day hikers on a park trail occurs with their exposure to behavioral cues located at or near areas where such behavior occurs.

Barriers and signs represent an opportunity to affect the behavior of those visitors who were not influenced by or exposed to other park communication efforts. Similarly, the presence of a uniformed employee may also create a salient reminder of appropriate behavior.

The study established that onsite behavioral cues do influence behavior. To accomplish their purpose, onsite cues must provide motivational incentives that are understood and effective among diverse populations. The observed variable effects of signs, barriers, and the presence of uniformed employees on noncompliant visitor behavior suggest that decisions on the use of on site cues must include more consideration of the type of intervention and the impact of such visitor controls on the behavior and recreation experience of the visitors. The studies represent an important first step in the necessary behavioral research to assist resource managers in controlling undesirable visitor behavior.

Swearingen is an assistant professor in the Department of Health, Physical Education, and Leisure Services at the University of South Alabama, Mobile, Alabama 36688, (205) 460-7131.

Johnson isa social science project leader with the University of Washington Cooperative Park Studies Unit, CFR AR-10, National Biological Survey, Seattle, Washington 98195, (206) 685-7404.

Western Park Personnel Meet on Mountain Lion-Human Encounters

By Bruce Moorhead and Terry Hofstra

Close-encounters and attacks on humans by mountain lions (*felis concolor*) have increased in the past 20 years in western North America and in a number of parks. In April, a lone female runner was killed by a lion in the Sierra Nevada foothills east of Sacramento; this was the second runner fatality in three years (a Colorado runner was killed in 1991) and the fifth lion attack in California since 1985. In Olympic NP, 33 lion-human encounters (i.e., sudden unexpected meetings at close range) and five near-attacks have been reported since 1991 with at least 12 occurring in 1994. Several other western national parks (Sequoia, Redwood, Big Bend, and Yosemite NPs) report similar patterns with two attacks occurring in Glacier NP in the past five years. This trend presents a visitor safety problem, has legal ramifications, and requires timely preparation by park resource managers.

On July 12-13, we participated in a workshop at the University of California, Davis (UCD) on managing lion-human conflicts in western parks. The workshop was sponsored jointly by Redwood NP and the CPSU/UCD. About 30 persons participated, including lion and legal experts, houndsmen, rangers, biologists, administrators, and interpretive specialists from various national parks (Glacier, Olympic, Sequoia and Kings Canyon, Yosemite, Lassen Volcanic NPs, Redwood National and State Parks), Whiskeytown and Golden Gate NRAs, the Western Regional Office, and the California Park Service.

Dr. Howard Quigley of the Hornocker Wildlife Research Institute summarized lion ecology and behavior based on long term research in Idaho, Yellowstone and Glacier NPs, and New Mexico. In unhunted populations, adult lions (>two years old) occur in rather stable social territories that tend to limit population density, with one male territory typically overlapping several (three to five) female territories. Relations between lions in territories (outside of breeding) vary from tolerance to serious fighting and frequent deaths. Female territories are more responsive to prey changes locally. Young animals dispersing from natal territories can move 300 miles in search of home ranges; lingering in an adult territory can amount to a death sentence. These transient animals often interact with humans. Research is still needed, however, on the habituation of lions to people and encounter/attack rates as the human population increases and people move closer to lions.

Dr. Paul Beier, University of Northern Arizona, summarized and expanded on his published research on lion attacks (Beier. 1991. Cougar attacks on humans in the U.S. and Canada. *Wildl. Soc. Bull.* 19:403-412). Overall, the risk of a lion attack is very small although it is increasing and is causing concern in some areas. In the 100 years from 1890-1989, about 50 humans were injured, while 10 people were killed due to lion attacks. The majority of victims (66%) were unsupervised children or lone adults; 60% of the attacks occurred in British Columbia. In the 20 years from 1970-90 (since the end of bounty hunting), the risk of an attack increased five times (from 0.4 human deaths/100 yrs to 2.5/100 yrs).

Avoiding Attack

While children are most vulnerable to attack, risk is much lower when accompanied by an adult. Similarly, people traveling in groups are more difficult targets for lions. At close range, lions may interpret deference in people as increased (prey) vulnerability. Therefore, when encountering a lion, people should stand their ground, not run, be assertive, keep their eyes on the animal, not play dead, and fight back, if necessary.

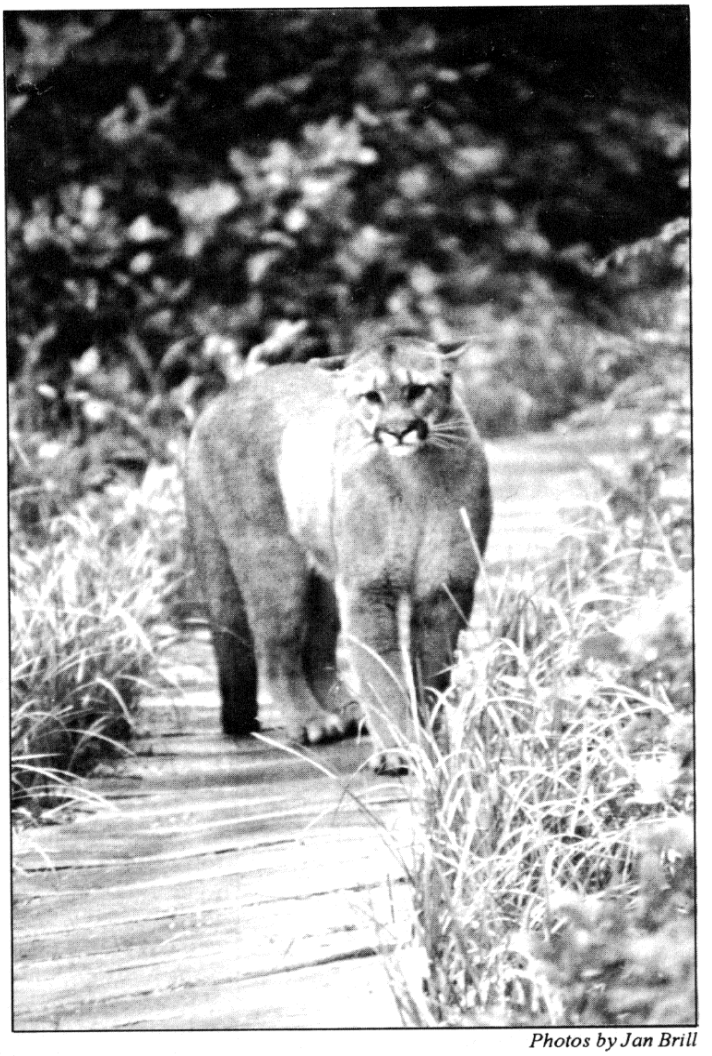
Bill Clark of California Wildlife Investigations Lab discussed the protocol for investigating incidents, such as the April 1994 fatality where a lone female runner was killed and partially consumed in a state park east of Sacramento. Assume that you'll be sued, and act immediately to protect the scene of an injury or fatality and to permit identification of the lion involved (by tracks, etc.). For forensic work, time is also critical since tissue and other evidence either decomposes rapidly at a scene or is digested by the animal. In the April fatality, human autopsy data, lion tracks, and reference skulls were used to develop a profile of the lion being sought based on its cranial characteristics inferred from bite wounds and other clues. Chase dogs captured the right lion soon thereafter, underscoring the value of tracker availability. The cat's identity was confirmed by DNA analysis of human tissue residues found at the base of its claws. The animal was a lactating female with cubs.

The field solicitor of the Department of the Interior and the deputy attorney general for California addressed park liability issues. While liability is evaluated case by case, it depends largely on whether or not a park is aware of a safety threat (not reasonably to be expected by the average visitor) and whether or not due warning is given. Everyone entering a park where lions are being observed or frequently encountered should be informed of the natural presence of and potential hazards posed by lions (e.g., by entry brochures and posted signs). Reports of lion sightings and interactions with people should be taken seriously, documented, and investigated. More specific warnings should be posted (and areas closed temporarily if warranted) where multiple lion observations and encounters occur. Warnings should be neither too soft nor unduly alarming, but must communicate the presence of lions in an area, the potential hazards, how to reduce the likelihood of encounter, and what to do if you meet an animal.

On the second day of the workshop, the group developed uniform mountain lion management guidelines for federal and state parks. Terry Hofstra of Redwood NP is editing the guidelines to include sections on policy and purpose, management alternatives and tactics, documentation and data management, and education and communication.

Some of the management recommendations include encouraging parks with increasing lion-human interactions to (1) complete local response plans; (2) standardize lion sighting/incident report forms and management response procedures--lion behaviors (movements, postures, characteristics of eyes, ears, mouth, tail, etc.) observed during encounters (as summarized by Dr. Lee Fitzhugh/UCD) can aid personnel in placing a particular behavior on an ascending scale of attack risks; (3)control/minimize lion attractants, such as pets, raccoons, carrion, and improperly

Olympic NP visitor and photographer Jan Brill and a partner encountered a mountain lion suddenly when hiking the popular boardwalk trail between Ozette and Sand Point. What began as excitement for the wildlife viewing opportunity turned to concern as the lion neared the hikers.



Photos by Jan Brill

Noting the lion's ear position, Brill decided to wave his arms (see sidebar). The lion sauntered off into the brush ending a typical and potentially hazardous lion-human encounter.

stored human food and garbage in inholdings and recreation facilities; (4) recognize that a close encounter is potentially very dangerous and complex--a lion's behavior can rapidly escalate or shift back and forth between secretive, curious, defensive, or offensive depending in good part upon what people do; (5) advise the public to become assertive and counter-aggressive when a lion behaves aggressively or is reluctant to leave an area; (6) promptly haze lions away from dense public use areas; (7) realize that translocation of problem mountain lions is complicated by considerations of park size and neighboring land use, and may cause fatal territorial competition between lions; (8) develop interagency arrangements to ensure that qualified personnel are available to capture and remove problem animals as needed; and (9) train rangers and interpreters to educate visitors about the hazards of mountain lions and appropriate human responses during an encounter. The group also identified as priority needs establishment of a lion technical coordinating group, to improve communication among parks and lion experts, and creation of a central database.

In conclusion, mountain lion-human interactions are increasing in a number of western national and state parks. Reports of lions should be documented, acted on, and taken as seriously as grizzly or black bear reports. Managing these incidents is more complicated than for black bears, however, due to the predatory behavior potential in lions. Serious incidents often develop through a rather unpredictable pattern of "cold" to "warm" reports from visitors which can either foretell something "hot" soon to follow, or nothing at all. Adequate public warning in parks is the first priority, followed by prompt efforts to remove or control pets or other food attractants. This trend indicates a timely need for improving management planning, bettering lion behavior and habituation information, and upgrading education in parks.

Moorhead is a wildlife management biologist at Olympic NP and can be reached at 600 E. Park Ave., Port Angeles, WA 98362, (206) 452-4501. Hofstra is chief of research and resource management at Redwood NP. Contact him at P.O. Box 7, Orick, CA 95555, (707) 488-2911 to request a copy of the mountain lion management guidelines.

Changing Diversity of Mollusks in Zion Canyon

Is This Fauna Recovering From a Prehistoric Flood?

By Wayne L. Hamilton

Sometimes valuable ecosystem data are just waiting to be found in some file folder in an out-of-the-way cabinet. Deciding what deserves closer scrutiny requires "pure" thoughts, because the significance of small components is often overshadowed by the "popular" fauna of the day. When I saw the file containing data on snails in the library at Zion in 1974, I didn't immediately know that I was interested, or that mollusks could help me interpret ancient sediments of ponds and lakes preserved in the canyons of the park. Not long after, I remembered a course I'd taken and recalled that the different species of mollusks have different habitat preferences. I quickly decided to become better acquainted with these tiny creatures and see how their shells could be used as fossil indicators of past environments in the canyons of the park. Later, it came as no surprise that their living descendants could also tell a story about very recent changes in Zion Canyon.

"The Snails of Zion National Park" is an undated manuscript by Angus Woodbury, a park naturalist at Zion, probably written as a draft of his report later published in *The Nautilus* (Woodbury 1929). This report represents the earliest molluskan inventory of which I am aware, for Zion Canyon. He listed 15 species collected in Zion Canyon, discussed numbers, and described collecting localities (8) and habitats. That study collection is kept in the park museum.

Following closely on Woodbury's inventory, Chamberlin and Jones (1929) collected in the canyon and confirmed all but one of the earlier finds and added a new terrestrial species. Shortly thereafter, Chamberlin and Berry (1930) added another terrestrial snail. The collections of the 1920s constitute, in my opinion, a relatively complete inventory.

In 1935, Wendell O. Gregg collected and identified mollusks at all of Woodbury's locations, plus three others, in Zion Canyon, adding five new species to the earlier list (Gregg 1940). By collecting in May, June, and July, he was assured that most species were active. Gregg's work was the basis for the handout given to visitors in the 1970s. His list qualifies as an inventory.

The next data were provided in a letter from C. L. Richardson (1965) who collected in the park in late May 1965, concentrating on aquatics. Richardson mentioned only three collecting localities.

My collection dates from 1974 to 1977, and it includes both species presently living in the canyon (at most of the locations surveyed earlier) and fossils collected from 4,000-year-old sediments of a slide-dammed lake there (Hamilton 1979, 1992 and forthcoming). My first tutor in identifying mollusks was Alice Lindahl (then at Utah State University), discoverer of an unnamed, probably *Amnicola* sp., at Grapevine Spring. These first identifications were checked, and in several cases corrected, by Jerry Landye (Flagstaff). Thereafter, I worked on my own, but the identifications listed here were further checked (and corrected) by R. Hanley (University of Michigan). All specimens have been deposited in the park museum.

In this update I present in graphical form (fig. 1--page 23) these earlier lists, indicating nomenclature changes conforming to Burch (1962 and 1989), with more emphasis on aquatic species collected in Zion Canyon. Table 1 shows all species and the localities of aquatics. Underlining indicates that a species was collected by the investigator. Very few of these mollusks have common names.

Figure 1 illustrates the changing number of aquatic mollusk species (including one seed clam) and terrestrial snails found in Zion Canyon over time. Aquatic species require pond, stream, or spring habitat while terrestrials live on moist surfaces near flowing water, under logs and in leaf litter, depending partly on precipitation for moisture. The total number of aquatic species appears to have increased since the time of the earliest inventory. The number of terrestrial species observed has declined slightly. Are these changes in diversity, or simply a result of observational bias?

One probable new arrival is *Physella virgata.* Woodbury (1930) identified it at a locality west of the park in 1926, yet he did not report this species in Zion Canyon. Similarly, Chamberlin and Jones (1929) and Gregg (1940) failed to report any Physid other than *Physa zionis* (discovered by Pilsbry in 1925) in the canyon. The first record of another Physid was from Richardson (1965), who reported *Physa ancillaria* Say ". . . in the stream near Weeping Rock, at the Amphitheater, and in springs along the Narrows Trail." In the mid-1970s, I identified the Physid common at this and other locations where clear, spring-fed tributaries descend to the valley floor, as *Physella virgata* Gould. Bequaert and Miller (1973) do not list *P. ancillaria,* and I believe that Richardson may have actually seen *P. virgata,* which resembles and which is now common at exactly those locations. I suggest that earlier collectors would simply not have missed seeing *P. virgata* if it had been as abundant then as it was in the 1970s. It probably moved into the canyon between 1935 and 1965.

P. virgata was found as a fossil in 4,000-year-old shoreline sediments of Sentinel Lake in Zion Canyon (Hamilton 1979). If suitable habitat existed then, why was this snail later extirpated?

Gregg (1940) reported *Lymnaea bulimoides* in a stream at Saddle Nook in 1935, but when Woodbury visited that stream before 1929 he failed to find it. This too suggests immigration. I did not attempt to verify this *Fossaria* colony.

Fossaria obrussa Say (Golden Fossaria) was identified west of the park as *Lymnaea obrussa* by Woodbury (1929), but it was not known in Zion Canyon until I found numerous shells in a spoil bank along a drainage ditch at Temple of Sinawava. This suggests either that the species occupied that site in the recent past and has been extirpated, or that it is a recent immigrant. If living specimens were to be found, this question would be resolved.

The *Fossaria dalli* in Table 1 (see page 24) was collected along with other Lymnaeids and identified long after being collected, therefore its locality is given as Temple of Sinawava (?), the query indicating uncertain locality.

The number of terrestrial snail species has remained relatively constant over time, or decreased slightly (fig. 1). Yet, because of their small size, obscure habitat, much greater diversity, and wider distribution in relation to aquatics, it is difficult to exclude observational factors as the cause of apparent changes in species diversity. Terrestrials are capable of surviving dry periods, but prolonged drought can have

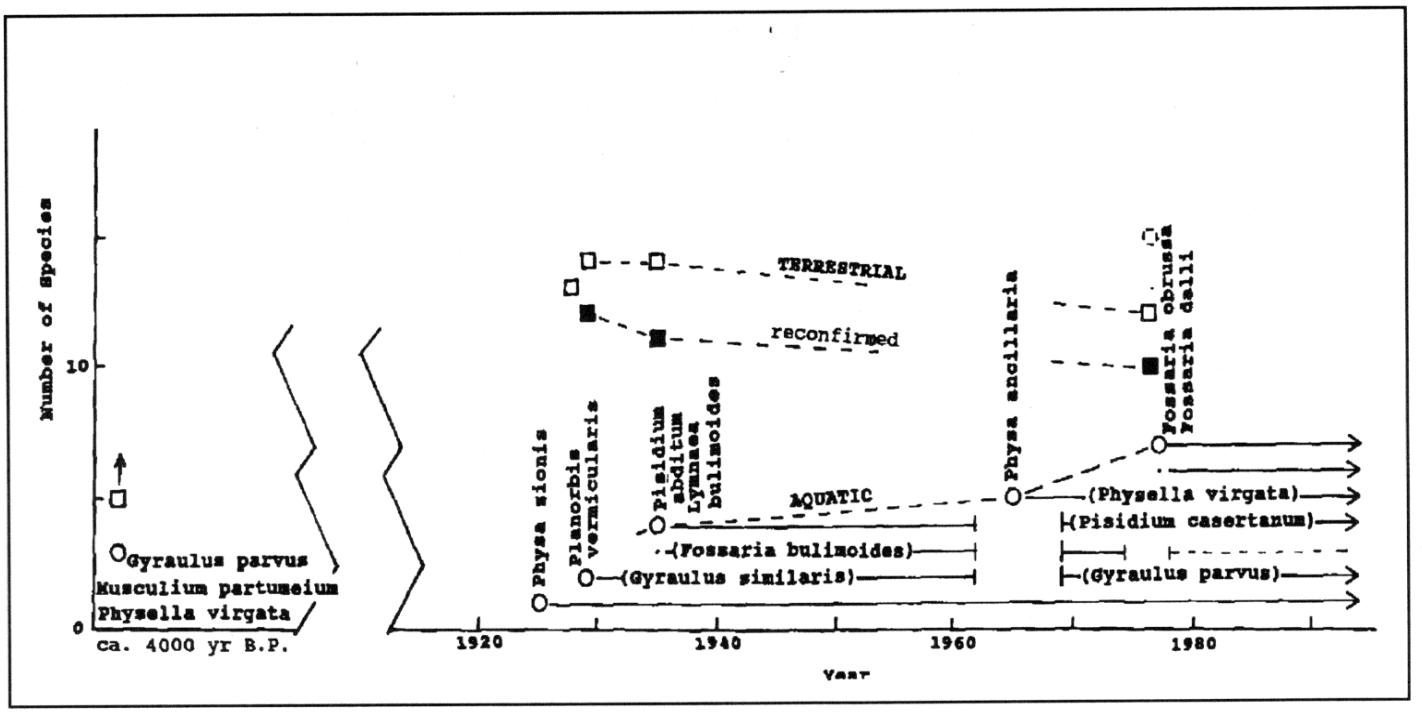


Figure 1. Number of terrestrial and aquatic mollusk species in Zion Canyon versus time. Species name changes are noted in parentheses. Lower half of diagram shows aquatic species. with totals represented by open circles. Terrestrial species are shown by squares. Solid squares represent number of species reconfirmed from earliest survey. Hollow squares show totals including new discoveries. Open, dashed square includes species in earlier surveys represented only by fossils in the 1970s.

serious consequences when springs stop flowing. The trend is interesting enough to warrant further investigation.

In the case of the apparent influx of *Physella virgata* and the possible recent immigration of *Fossaria obrussa* and *F. bulimoides,* what agencies might be considered? The Zion localities are all connected to the North Fork of the Virgin River, in which brown trout (and other fish) are common. Introduction of eggs or juvenile forms by fish seems a reasonable explanation for the arrival of new species. Water birds have also been suggested as a vector for snail introduction at isolated ponds at Badlands (Beetle-Pillmore 1994).

And what may have removed *P. virgata* and extirpated other species that are now established in the canyon? Most of the habitat lies within the 100-year floodplain of the North Fork of the Virgin River. Moreover, most spring-fed tributaries are situated at the base of hanging canyons cut in the Navajo Sandstone, having sizeable watersheds (Hamilton 1992). This puts such habitat in range of torrential flooding when waterfalls scour drainages that are usually placid. We may be seeing a recovery, supported by natural dispersal, from such a disturbance early in the century. Perhaps such episodes are a normal part of the dynamic canyon ecosystem.

Physella zionis, an endemic species, is better adapted to survive floods in Zion Canyon because its habitat is on near-vertical surfaces where springs issue from the Navajo Sandstone above the canyon floor. Seed clams might similarly survive if the sediments where they burrow were not excised or deeply buried by flooding. A small population of *Gyraulus parvus* persisted in the 1970s only at a spring-fed bog well above the floodplain at Birch Creek. This may have been the only surviving population from ancient Sentinel Lake. The bog (once a pond) at Birch Creek is vulnerable to drying because it has been tapped as a water supply source.

These small invertebrates are an important constituent of the canyon ecosystem. They are a valuable food source for birds and other small vertebrates and insects. In contrast, and in spite of their seeming insignificance, they also play a role in limiting other inhabitants of the canyon. When accidently ingested with forage, *Z. arboreus* can infect sheep with lungworm. *C. lubrica* similarly acts as a vector for the lancet liver fluke that infects deer and wild sheep (Burch 1962). Some aquatic species carry schistosomes that are transmitted to humans who wade in infested waters.

Further inventory is recommended as a means of testing the hypothesis of immigration of aquatic snails proposed here. Habitat is also subject to encroachment by exotic competitors, and a lookout should be maintained for them. In the late 1980s, the exotic species *Helix aspersa* was poised for immigration in irrigation ditches near the park boundary at Rockville.

Some terrestrial snail habitat is vulnerable to acid precipitation, which can hypothetically reduce soil alkalinity to the point where the organism can no longer maintain its protective calcium carbonate shell. More generally, the niches occupied by mollusks are subject to loss through drought, flood, and fire. The mollusks discussed here depend on a variety of habitats, and their presence or absence implies something of the health of the ecosystem. Future inventorying may shed light on the significance of the small reduction of terrestrial species over time.

Hamilton worked in Zion NP beginning in 1974 as a ranger and, on contract with the Zion Natural History Association, as a naturalist producing a geologic map, a book on the park's geology, and several other publications. He moved to Yellowstone NP in 1980 where he now works as a geologist with NBS. He is at the Greater Yellowstone Field Station, National Biological Survey, Yellowstone National Park, WY 82190, (307) 344-7381.

References

Beetle-Pillmore, D. 1994. Letter to the author.

Bequaert, J.C., and W.B. Miller. 1973. *The Mollusks of the arid Southwest, with an Arizona check list.* Vol. 16. Tucson: The Univ. of Arizona Press.

Burch, J.B. 1989. *North American freshwater snails.* Hamburg, Michigan: The Univ. of Michigan, Malacological Publications.

Continued on page 24

Table 1

Woodbury 1, Pilsbry 2, Chamberlin & Jones 3, Chamberlin & Berry 4 (1925-30)		Gregg (1935)	Richardson (1965)	This Work (1974-77)
				Oreohelix cf. subrudis ("Pfeiffer"Reeve?)
Oreohelix cooperi 1,3	[common]	*Oreohelix strigosa depressa*		*Oreohelix strigosa depressa* (Cockerell)
Microphysula ingersolli 2				*Microphysula ingersolli* (Bland) F
Econulus fulvus 1,3	[v. rare]			*Econulus fulvus alaskensis* (Muller) F
Glyphyalina indentata 1,3	[uncom.]	*Retenilla indentata* (Say)		*Glyphyalinia indentata paucilirata* Morelet
		Hawaii minuscula neomexicana		
Zonatoides arborea 1,3	[common]			*Zonatoides arboreus* (Say) F
Vitrina alaskana 1,3	[widespread]			*Vitrina pellucida alaskana* Dall a,g
Agriolimax campestris 1,3	[common]			*Deroceras laeve* (Muller)
Gonyodiscus cronkhitei 1,3	[widespread]			*Discus cronkhitei* (Newcomb) F,d
Succinea avara 1,3	[common]			*Catinella avara* (Say) F,a
Gastrocopta ashmuni 4				
Pupoides marginatus 1,3	[v. rare]			*Pupoides albilabris* (Adams) ?
Pupilla syngenes dextroversa 1,3			*Pupilla blandi*	
				Pupilla muscorum (Linne) f
Pupilla syngenes 1,3				
		Vallonia pulchella [introd?]		
		Vallonia perspectiva		*Vallonia perspectiva* Sterki F
Vallonia gracilicosta 1,3	[rare]	[v.common]		*Vallonia excentrica* (Sterki 1893) f
Cochlicopa lubrica 1,3	[widespread]	[v.common]		*Cionella lubrica* (Muller) f
				Fossaria dalli (Baker) ?
				Fossaria obrussa (Say) d
		Fossaria bulimoides b		
			Physa ancillaria c,d,e	*Physella virgata* (Gould) c,d,e F
Physa (Petrophysa) zionis 2,3,d				*Physella (Petrophysa) zionis* d
Gyraulus vermicularis 1,3,a		*Gyraulus similaris* a		*Gyraulus parvus* (Say) a F
		Pisidium abditum a		*Pisidium (cyclocalyx) casertanum* (Poli) d

a. Birch Creek pond, b. Saddle Nook, c. Amphitheater, d. Temple of Sinawava, e. Weeping Rock stream, f. Oak Creek, g. Lava Pt., F. fossil, ?, location uncertain (see text)

———. 1962. The Eastern Land Snails. *Pictured key nature series, how to know.* Dubuque, Iowa: Wm. C. Brown Co.

Chamberlin, R.V., and E. Berry. 1930. Molluska from the Henry Mountains and some neighboring points in Utah. *Bull. of the Univ. of Utah* 21:2,4.

Chamberlin, R.V., and D. Jones. 1929. A descriptive catalogue of the molluska of Utah. *Bull. of the Univ. of Utah* 1-9:1-203.

Gregg, W.O. 1940. Mollusca of Zion National Park. Utah. *The Nautilus* 54:1,30-32.

Hamilton, W.L. 1979. Holocene and Pleistocene lakes in Zion National Park, Utah. In *Proc. of the First Conference on Scientific Research in the National Parks.* Edited by R. Linn. 835-844. New Orleans Conference: NPS and Am. Inst. Biol. Sci. 1977.

———. 1992. *The sculpturing of Zion.* Zion National Park, Utah: Zion Natural History Assn.

———. Forthcoming. Quaternary ponds and lakes of Zion National Park, Utah. In *Quaternary of the Colorado Plateau.* Edited by J. Mead and L. Agenbroad. Flagstaff: Museum of Northern Arizona.

Pilsbry, H.A. 1925. A fresh-water snail, *Physa zionis,* living under unusual conditions. *Proc. Acad. of Natur. Sci. of Philadelphia* 77.

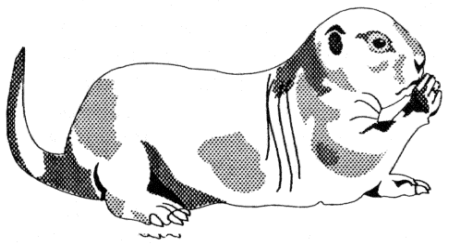
Richardson, C.L. 1965. Letter to park naturalist Ro Wauer. *National Park Service files.* Zion National Park, Utah.

Woodbury, A.M. 1929. The Snails of Zion National Park. *The Nautilus* 43:54.

Prairie Dog Control at Fort Larned, Kansas

By Felix Revello, George Elmore, and James David

Fort Larned National Historic Site preserves original Santa Fe Trail ruts as a part of its cultural landscape. This 40-acre detached area where the ruts are located is also home to a colony of prairie dogs whose burrows are a threat to the historic ruts. While the park has managed the tract to maintain both its historic and natural values, its mandate places protection of the ruts first.



Despite control measures in the past that included both poisoning and shooting, the prairie dogs continually reestablish themselves in the historic ruts. In April 1992 (after viewing a news story on a clever new method of control), and again this past May, the park used the innovative, but more expensive, treatment. The method involves using a modified sewer vacuum truck to suck the animals out of their burrows.

The contractor begins by first filling in most of the burrow openings with soil in order to identify the holes in use by the "dogs." Holes also used by the burrowing owl are left open and are not vacuumed so as to minimize disturbance of the symbiotic birds. The following day the vacuum truck circulates to the burrows that had been reopened during the night by the prairie dogs. The contractor inserts a large hose into each burrow to suction up everything close to the surface, including any prairie dogs. The truck is modified to protect the animals as they pass from the

Labrador Retriever Assists in Ecological Research

By Allan F. O'Connell, Jr.

As part of an ongoing research project, Gateway NRA biologist Bob Cook recently purchased a labrador retriever to aid in collecting box turtles. Known as Gus, the retriever locates and retrieves reintroduced box turtles *(Terrapene carolina)* in an attempt to determine their movements and survival rates.

Long Island, NY, was once a stronghold for the box turtle, but the population has declined due to habitat loss and urban development. As part of a larger effort to reintroduce and maintain viable populations of locally native reptiles and amphibians, Gateway staff have experimentally reintroduced over 300 box turtles into Floyd Bennet Field, a grassland section of the park.

Staff outfitted turtles with radio transmitters to determine home range and movements, but soon encountered problems relocating the animals due to limited transmitter range, dense vegetation, and the small size of the turtles. For help, Bob Cook contacted a colleague in Maine who owns and trains retrievers for field trials and who, in turn, contacted Dave Mosher of Sugarfoot Kennel, a professional retriever trainer. Cook purchased Gus from Mosher who owned a litter of puppies sired by a former national amateur field champion retriever. Cook then shipped to Maine turtle shells, as well as a live specimen, and training began. (Gus is trained as a "non-slip" retriever, a term used to indicate that the dog retrieves only on command).

Trainer Dave Mosher of Sugarfoot Kennel, Burnham, Maine with Gus who is holding a box turtle shell.

Gus has now completed two summers collecting turtles and has located and retrieved individuals with and without radios. Although Gus will never compete in field trials and does not hunt waterfowl, he has contributed his share to natural resource management and conservation; he has helped staff to understand better the ecology of this fragile population by increasing sample size. The moral of this story: a dog is truly a man's best friend!

Allan O'Connell is a research wildlife biologist with the NBS and leader of the NPS CPSU at the University of Maine in Orono; he also runs retrievers in nationally sanctioned field trials.

Prairie Dog Control *(Continued)*

large-diameter hose into the hopper where a padded deflection screen catches them.

In 1992, the weather was not helpful. Cold temperatures and high winds drove the prairie dogs deep into their burrows, reducing the effectiveness of the experiment. That year, only five prairie dogs (all appearing healthy) were captured. In 1994, 40 animals were trapped (three died). Resource managers compared pre- and post-treatment counts of prairie dog relative abundance and concluded that the effort had mixed results.

The treatment area had been divided into eastern and western plots of which the western section yielded better results. This was because most of the burrows there had two or more entrances and unclogged passageways, whereas the eastern plot was made up of burrows with either single openings or constricted subterranean passages. The contractor explained that vacuuming is ineffective on burrows with only one opening or blockages as only a static vacuum is created; this effect is similar to clogging the hose on your household vacuum. Each burrow must have at least two entrances and clear passageways to obtain the air exchange necessary to generate the high speed air flow required to pull prairie dogs out of their burrows.

Before starting this project, we had no idea how many prairie dogs could be removed using this vacuuming technique. In the hopes of finding someone to adopt the animals, we had contacted numerous organizations before beginning the project. Fortunately, the Kansas Department of Natural Resources was able to take all the dogs provided and translocated them to Cheyenne Bottoms Wildlife Area.

This method of capture lacks the dangers associated with poisoning and is less objectionable than either poisoning or hunting. Public support and interest even ran high as judged from the newspaper and television coverage of the initial event. However, our take included other nontarget species (in 1994) including one burrowing owl (the first ever for this contractor), salamanders, mice, and numerous beetles (all released unharmed). One unexpected offshoot from this project was interest from the NBS (Dr. Jerry Godbey of the Mid-continent Ecological Center in Fort Collins, 303/226-9460) who would like to survey invertebrates taken from prairie dog holes during the vacuuming process. Godbey feels that this technique may produce new species discoveries.

Following two experiments with this method, we conclude that this procedure is presently expensive, averaging $30-$40 per prairie dog, and is only moderately effective (the contractor has had much better results with other clients, however). It can be justified only for very small prairie dog towns or limited removals in high visibility locations. Then, it will be most effective if used on burrows free of blockages. The technique might also be useful where other control methods might be injurious to threatened and endangered species.

Revello is Chief Ranger at Fort Larned; Elmore is Resource Management Specialist, 316/285-6911; David now is at Horseshoe Bend National Military Park, Alabama, 205/234-7111.

Captive Cougars May Aid Florida Panther Project

By Craig S. Johnson and Joseph D. Clark

The Florida panther (*Felis concolor coryi*) is one of the rarest mammals in the world. Less than 50 animals inhabit 1.5 million ha of land in south Florida, the bulk of which includes the Big Cypress National Preserve (Maehr 1990). More than 45,000 ha of additional land will soon become part of the preserve and most of the Florida panthers at Big Cypress live on those additional lands. An environmental assessment for recreation access to the addition lands calls for monitoring and studies of the Florida panther, its prey, and human visitors. Most public use of the area is associated with hunting for deer (*Odocoileous virginianus*) and hog (*Sus scrofa*) since 1980. Although direct panther mortality as a result of those hunts has not been documented, potential impacts to panthers could result from excessive disturbance by hunters and activities associated with hunting, such as off-road vehicle use. Therefore, we initiated a study in 1993 to test the hypothesis that panther habitat preferences, activity patterns, energy expenditure, and prey are impacted by public use.

A number of panthers are currently being radiotracked by the Florida Game and Fresh Water Fish Commission to monitor the status of the cats (e.g., mortality, home range, reproductive status), but the schedule and timing is not adequate to address the objectives of our research. Those efforts probably are not of sufficient scale or intensity to detect more than gross shifts in home range. However, more subtle changes in panther behavior may occur due to human disturbance and could have a significant impact on their fitness. We wanted to be able to detect these less dramatic, yet potentially important changes in panther behavior, if they were actually occurring, and we wanted to look into some new techniques for doing so.

We began concentrating on how we might obtain more detailed information using the telemetry collars currently worn by the panthers. Equipped with mercury tip-switches, the collars being worn by the panthers indicate whether the head is up or down by transmitting either a fast or slow pulse rate. However, no one has determined whether the tip-switches are accurate in characterizing cougar activity, although analyses have been conducted for other species such as Dall sheep (*Ovis dalli*) (Hansen et al. 1992), elk (*Cervus elaphus*) (Green and Bear 1990), black-tailed deer (*O. h. columbianus*) (Gillingham and Bunnell 1985), and white-tailed deer (Beier and McCullough 1988).

We learned of a local Knoxville man with a number of captive cougars and facilities to enable them to move about in a seminatural environment. We contacted him and were able to obtain permission to fit the cats with collars identical to those at BICY to evaluate the tip-switches for characterizing activity.

To conduct the experiment, we fitted a radiocollar on one of two captive western cougars (named Marcos and Moses) and simultaneously recorded activity and the radio pulse rate. We had planned to use both cougars equally, but, on the first day, Marcos (being fully equipped with claws and teeth) politely informed us that he did not like to be collared. Therefore, in order to keep him happy (and Craig in possession of all his body parts), we decided to use only Moses in our study. Moses and Craig got along great and it did not take long for the cougar to associate the appearance of Craig and the radiocollar with "play time."

The collar was placed on Moses so that, when his head was up, the collar emitted a signal with a fast pulse rate, and when his head was down, the collar emitted a slow signal. Movements by the cougar were categorized as walking, standing, running, sitting, or lying.

On the first day, we noticed that certain movements caused a specific pulse to be generated most of the time. For example, walking caused a slow pulse signal, while standing, sitting, and lying generally created a fast signal. We recorded the pulse signal and direct observations on microcassette tape and later entered the data into a computer spreadsheet.

Preliminary analysis of the activity data is encouraging. We combined all observations (9+ hours) and broke them into 5-minute intervals. Activities with similar energy costs were classed into two groups: active (walking, standing, running) and inactive (sitting and lying). We included standing in the active category, because time spent standing was usually an intermediate behavior between walking bouts. The animal spent minimal time running. Based on the percentage of time that the collar pulse indicated a head up position, we found that we could correctly classify the cougar as active (>60% walking, standing, or running in a 5-minute time interval) 69% of the time (24 out of 35 instances). Likewise, we could classify inactivity (>60% lying or sitting) 79% of the time (41 of 52). Based on these results, and after further refinements from additional forthcoming captive cougar data, we can classify gross activity level of the Florida panthers with a good chance of being correct.

With this model, we are now making arrangements to collect similar data on the wild panthers at Big Cypress to assess human disturbance. We have obtained a number of portable, telescoping radio towers and a chart recorder to monitor the cats. With that equipment, we should be able to obtain continuous data on activity for selected panthers, and the data will be compatible with the above model for analysis. In so doing, we can obtain activity data (day and night) without actually having to know the exact location of the panthers. We can also compare data from areas that are being hunted (treatment) with areas that are not (control). Then, we can develop a statistic to apply to our study objective using the mercury tip-switch technology. There may even be many ways to extrapolate this statistic into a crude measure of energy expenditure (Gessaman 1973, Ackerman 1982, Corts and Lindzey 1984), a question we will investigate as our research progresses.

References

Ackerman, B.B. 1982. Cougar predation and ecological energetics in southern Utah. Master's thesis, Utah State University, Logan.

Beier, P., and D.R. McCullough. 1988. Motion-sensitive radio collars for estimating white-tailed deer activity. *J. Wildl. Manage.* 52:11-13.

Corts, K.E., and I.G. Lindzey. 1984. Basal metabolism and energetic cost of walking in cougars. *J. Wildl. Manage.* 48:1456-1458.

Gessaman, J.A. 1973. *Ecological energetics of homeotherms: a view compatible with ecological modeling.* Monograph Series, no. 20. Logan: Utah State Univ. Press.

Gillingham, M.P., and F.L. Bunnell. 1985. Reliability of motion-sensitive radio collars for estimating activity of black-tailed deer. *J. Wildl. Manage.* 49:951-958.

Green, R.A., and G.D. Bear. 1990. Seasonal cycles and daily activity patterns of Rocky Mountain elk. *J. Wildl. Manage.* 54:272-279.

Hansen, M.C., G.W. Garner, and S.G. Fancy. 1992. Comparison of three methods for evaluating activity of Dall's sheep. *J. Wildl. Manage.* 56:661-668.

Maehr, D.S. 1990. The Florida panther and private lands. *Conserv. Biol.* 4:167-170.

Johnson and Clark are with the CPSU at the University of Tennessee, Department of Forestry, Wildlife, and Fisheries, 274 Ellington Plant Sciences Building, Knoxville, TN, 37901-1071, (615) 974-0739.

Regional Highlights

Mid-Atlantic

Assisted by the NPS Mining and Minerals Branch, the U.S. Bureau of Mines (BOM), and regional Chief Scientist John Karish, Friendship Hill NHS is identifying and developing mitigation projects for the treatment of acid drainage from mines within the park. Although the interagency agreement between the two agencies has ended, BOM has continued to investigate the chemical and biological processes in the wetlands constructed at Friendship Hill for the purpose of acid mine drainage treatment.

BOM recently developed and evaluated a method for comparing the abilities of different organic additives (brewer's yeast, molasses, polylactic acid, and dairy whey) to stimulate sulfate reduction when added to wetland sediments. Bacterial sulfate reduction not only removes metals and sulfate from acid mine drainage, but also adds alkalinity. They tested both fermented and unfermented organic additives in the experiment.

Using an underground pipe system within the Friendship Hill wetlands, BOM pumped whey into the compost of one wetland lane and within two weeks, most of the whey had passed through the lane. Staff sampled the wetland water each week for four months monitoring changes in water quality. They found slightly lower sulfate concentrations in the treated lane following the whey addition and indicating that the single whey dose may have slightly affected bacterial activity. Future experiments will be based on a continual feed system.

* * *

Two visitors to Shenandoah NP reported seeing peregrine falcons on Stony Man Mountain in late July. Park staff investigated and discovered an eyrie with a male and female chick in excellent condition. USFWS staff banded the chicks and secured the area from human disturbance. The chicks fledged in mid-August.

* * *

Shenandoah's Fish In Sensitive Habitats (FISH), a three year research project, underwent its second year peer review in August. FISH will enable modeling of the affects of stream acidification on fish individuals and populations.

* * *

Recently signed by the regional director, Colonial NHP's Water Resources Management Plan will soon be ready for distribution. It contains an electrostatically-plotted map portfolio produced by the park's GIS (with the assistance of the North Carolina State University FTSC). Colonial is also continuing a fisheries inventory of park waters under an agreement with the USFWS Fisheries Assistance Office in White Marsh, Virginia.

North Atlantic

The Natural Resource Protection Program (NRPP)-funded study of storm breach threats to northern U.S. national seashores has begun. Jim Allen (former NPS coastal geomorphologist and now with NBS) is leading a group of investigators from the University of Rhode Island, SUNY/Stony Brook, and Rutgers who are studying the physical impacts of storm breaching on barrier islands dynamics and multiple inlet estuarine circulation at Fire Island NS, Cape Cod NS, and Sandy Hook/Gateway NRA.

The methodology uses numerical modeling calibrated by intensive field surveys which employ the latest technological developments (electronic total stations, kinematic GPS, remote pressure-temperature-salinity data loggers, etc.). The research will quantify the expected physical changes to barrier-estuarine systems in order to provide a basis for ecosystem impact assessments and breach management planning in this highly developed coastal environment.

* * *

Janice Minushkin of the regional office visited six national natural landmarks (NNLs) this year in preparation of the annual section 8 report. She focused on threatened and endangered NNLs and reports that one site, Acushnet Cedar Swamp in New Bedford, Massachusetts, included in last year's report, will be removed this year because threats to the site have been mitigated by the state park that manages the property.

Southeast

Blue Ridge Parkway and North Carolina Wildlife Resources Commission conducted a stream restoration project on Little Glade Creek on the parkway in Allegheny County, North Carolina during 1993 and early 1994. They improved water quality and trout habitat by excluding livestock from the riparian zone through installation of a fence. The project also aimed to increase vegetative cover and restore eroded stream banks.

Stream bank restoration consisted of installing an erosion-resistant foundation of root wads, rip-rap, or logs at the base of eroded stream banks at water level. Banks were sloped to this foundation at a 2:1 to 3:1 grade, smoothed, seeded, fertilized, and mulched. Crews repaired 23 sites totalling 292 m (950 ft.) and established 2 gravel livestock crossings. Project leader Bob Cherry estimated that more than 450 work-hours and $17,000, including materials and salaries, were expended on this project.

* * *

Twelve Blue Ridge Parkway employees spent four days in the hot sun in June planting more than 800 Heller's blazing stars *(Liatris helleri)* along the Grandfather Mountain Corridor. Heller's blazing star is a federally listed plant that occurs on the Parkway and in only six other locations in the world. The plants were reared in a greenhouse at the University of Georgia at Athens from seeds collected on the Parkway. They were moved to the North Carolina Arboretum in Asheville, North Carolina where the plants were maintained by horticulturalists and greenhouse personnel. Staff will watch this endangered plant population closely for several years to determine the effectiveness of the restoration effort. If successful, the population will have been augmented from around 150 naturally growing plants to more than 1,000.

* * *

Four parks in the southeast have begun long-term monitoring projects of amphibians. Blue Ridge Parkway, Cumberland Gap NHP, and Great Smoky Mountains and Mammoth Cave NPs have conducted field surveys and selected study sites for pond, stream, and terrestrial-breeding frogs and salamanders. The parks will focus on two species of temporary pond breeders (wood frogs and spotted salamanders) and six species of stream breeders. The plan is to collect temporary pond habitat data on water PH, conductivity, temperature, pond depth, total number of egg masses laid, and developmental stages of eggs and their survival in egg masses. Sampling stream and terrestrial breeding salamanders in 30 x 40m subplots, the researchers also hope to learn reproductive status (larva, juvenile, adult), body length, and distance of animals from streams.

* * *

Soil erosion is a major concern at Virgin Islands NP and is being studied by Dr. Lee MacDonald of Colorado State University. Soil erosion damages the coral reefs and other marine ecosystems, major features of the park, by increasing turbidity and redepositing the fine sediment. Along with his master's student Don Anderson, MacDonald is working to understand the erosion sources and sediment delivery mechanisms caused by development on the island of St. John in order to minimize the impacts on the marine resources.

The two researchers originally hypothesized that the majority of steep hillsides erosion is caused by overland flow and shallow landslides triggered by large tropical storms such as Hurricane Hugo. A site visit together with Dr. Bill Dietrich from the University of California at Berkeley revealed that neither overland flow nor landslides presently contribute much sediment to the process. While historic agriculture may have substantially increased erosion rates in the 18th and 19th centuries, vegetation regrowth early this century (following a population decline) may have reduced it to only slightly higher than presettlement conditions. Instead, they found soil erosion from unpaved roads to be the overwhelming cause of the problem. The researchers developed a GIS-based road erosion model to help predict the amount of sediment being generated and delivered for each catchment on St. John.

Dr. MacDonald hopes to follow this initial study with more intensive work on road erosion processes and the relative amounts of sediment generated from unpaved road surfaces, cut banks, roadside ditches, sidecast material, and culvert incision. This work should provide more detailed guidance for planning and mitigation purposes on St. John and other areas. A detailed article on the results of this initial study is planned for a future issue of *Park Science.*

* * *

Jim Renfro, air quality program manager at Great Smoky Mountains, is currently managing one of the NPS's most extensive and sophisticated air quality research and monitoring programs in any national park. Projects include monitoring ozone and assessing its effects on vegetation, studying visibility impairment from sulfate aerosols, and recording acidic deposition.

The NPS, Tennessee Valley Authority, Environmental Protection Agency, and State of Tennessee are currently funding several ambient ozone monitoring stations there. The benefits of this work will include a greatly improved understanding of the ozone exposures and precursors to ozone formation. The work will also provide an enhanced database on ozone exposure that will be helpful in assessing impacts to sensitive plants.

The park is also using a low cost means of monitoring ground-level ozone. The WASO air quality division funded a summer passive ozone sampler study to improve understanding of spatial variability away from continuous monitoring sites and to improve the exposure-response connection of foliar injury. The measurements were made near Cove Mountain and in the canopy of the northern hardwoods.

The EPA and TVA began a three-year study this summer at Cove Mountain and Twin Creeks at the park to study the ambient ozone effects on mature trees species. This work is extremely important in determining the physiological effects of ozone on sensitive hardwood species growing in the park. The last two years have shown that nearly 80 percent of the tall milkweed plants were injured and nearly 80% of the leaves on each injured plant was damaged from ozone.

The University of California at Davis recently reported that concentrations of sulfate particles worsened by 39% over the last 10 years in the park, more than in any other national park in the country. The park conducted an intensive visibility research study at Look Rock this summer to document the ammonium sulfate aerosols and to determine why current models, able to reconstruct measured light scattering at sites in the western U.S., are unable to do so in the east with the same accuracy. This study will improve the understanding of atmospheric sulfates and their impact upon visibility.

The Smokies have also recorded some of the highest sulfur and nitrogen deposition in the country. The EPA has selected Clingmans Dome (elevation 6,643 ft) in the park as one of four acid deposition monitoring sites as part of their CASTNet (Clean Air Status and Trends Network) Mountain Acid Deposition Program (MADMP). Data collected at the dome will be used to determine the effectiveness of emissions reductions mandated by the 1990 Clean Air Act amendments which require a 50% reduction in sulfur dioxide emissions by the year 2000.

* * *

Researchers from the NBS-CPSU at the University of Tennessee were very busy in August presenting papers and leading field trips at the joint Southern Appalachian meeting of the Ecological Society of America and American Institute of Biological Sciences. Held in Knoxville, the symposium was attended by 3,000 participants from the United States, Canada, Europe, South America, Africa, Asia, and Australia. Field trips and presentations focused on Southern Appalachian plant ecology, ecology and hydrogeology of the Mammoth Cave Karst aquifer, stream acidification, and many others.

Dr. Stephen Nodvin, Research Ecologist with the CPSU, and Dr. Niki Nicholas of the Tennessee Valley Authority led a symposium on multiple stressors to the high elevation spruce-fir ecosystem. As part of the symposium, Dr. Ted Simons of the NBS-CPSU at North Carolina State University presented a talk entitled, "Avian Diversity in Managed and Unmanaged Landscapes in the Southern Appalachians." The CPSU contributed many other papers and poster sessions..

* * *

Mammoth Cave NP and the Cave Research Foundation co-sponsored the Third Mammoth Cave Science Conference in July. Attended by more than 60 individuals, the research forum enabled in-depth discussion across specialty areas. The annual event benefits researchers and managers alike.

Pacific Northwest

The general management planning process for Mount Rainier will include addressing geologic hazards associated with the volcano. Members of the planning team from the Denver Service Center, park staff, and WASO, North Cascades, and regional geologists met with USGS and Washington Department of Natural Resources geologists at the Cascade Volcano Observatory to share information on the present state of geologic knowledge and ongoing research of Mount Rainier. They also identified research and monitoring needs.

The group devoted three days to examining facilities in the park located adja-

cent to major rivers that drain the volcano. Very little hydraulic, geomorphic, and channel profile information exists on these rivers within the park. As a result, the profile and rate of change of channel morphology and discharge capacity is poorly known. River channels will be surveyed to address geologic hazards associated with floods and debris flows which are a threat to life and property. Other potential hazards include rock falls, earthquakes, and processes associated with volcanic eruptions.

Mount Rainier is listed as a decade volcano by the United Nations. This designation applies to a select group of active and potentially active volcanoes around the world that are located near large population regions which could be severely affected during an eruptive event. The U.N. identified these volcanoes during the early 1990s as needing to be studied for their geologic hazards in the hope of providing forewarning and protection to the people living near them. Although no funding support is provided by the U.N. for geologic research on decade volcanoes in the United States (there is also one in Hawaii), designating Mount Rainier has increased concern over the variety and potential effects of geologic hazards. The upcoming Geological Society of America (GSA) Annual Meeting, to be held in Seattle in October, will give further attention to this on a field trip to Mt. Rainier.

* * *

Acting regional chief scientist Kathy Jope participated in the first two biweekly meetings of the Northwest forest ecosystem research and monitoring committee. Functions of the committee, which are called for in the record of decision on the Forest Plan, include research, monitoring, and scientific oversight of various aspects of implementation of the plan. This committee will provide a forum for coordinating agencies' research and monitoring throughout the range of the northern spotted owl, and will also help ensure that the agencies are addressing the research and monitoring needs called for in the record of decision.

* * *

Jope also gave a presentation to a group of teachers, consisting of two from every state as well as Washington, D.C., and Puerto Rico, participating in a two-week wilderness workshop sponsored by the NPS. While the presentation addressed NPS wilderness, it also emphasized the need to build a sense of connection between people and the environment, and a sense of personal responsibility for conserving healthy ecosystems everywhere if the natural systems in wilderness are to survive for long.

* * *

Craig Dalby coordinated the region's response to a request from the eastside ecosystem management project (EEMP) for data on visitation statistics, including spatial data for each of the eastside parks. As part of the EIS development for the Columbia Basin, the EEMP is looking at recreational opportunities, among other factors, using the Forest Service's recreational opportunity spectrum (ROS) classification system. Where possible, Dalby "crosswalked" NPS management zones into the ROS system for each of the affected parks, creating a corresponding spatial data set. These data, along with visitation figures from the parks, were sent to the EEMP.

Dalby and Marsha Davis coordinated the response to a second call from the EEMP, requesting grazing allotment data. The requested information included spatial data for grazing allotments at City of Rocks, John Day Fossil Beds, and Nez Perce, and attributes concerning the nature of the grazing activity for each allotment.

* * *

The Comprehensive Management Plan for City of Rocks is nearing completion. Marsha has been working with the planning team in reviewing and editing final revisions to the document. This included participation in a meeting, held in Boise, with representatives of Idaho State Parks, City of Rocks (NPS and Idaho State), and the regional office to review and discuss the final draft version of the comprehensive management plan.

* * *

The Pacific Northwest Region is tentatively planning the following natural resource training opportunities for FY95: GIS and GPS for Cultural Resource Management, Hazard Tree Management, Landscape Restoration Workshop, Planning for Resource Stewardship, Professional Development in Natural Resources, Regional Natural Resource Refresher Workshop, Orientation to the Management of NPS Resources (Natural and Cultural), Vegetation Monitoring Workshop, and numerous wilderness management correspondence courses.

Rocky Mountain

The wolves are coming! The way has been cleared for reintroduction of the gray wolf to the Yellowstone ecosystem and the USFWS has asked Canadian officials to provide 30 wolves this fall for relocation to the park and central Idaho. No lawsuits challenging wolf reintroduction are expected and wildlife managers are proceeding with recovery plans.

* * *

The black-footed ferret is coming, too! The last major hurdle to restoration of black-footed ferrets into Badlands NP and the Conata Basin in South Dakota has been cleared through publication of the special rule in the August 18 *Federal Register* establishing them as a nonessential experimental population. The NPS, USFWS, and USFS have worked for six years to bring the ferrets to the site. This will be the second reintroduction for the ferret and the first attempted in black-tailed prairie dog habitat. The first ferrets (from captive breeding facilities) should arrive soon after Labor Day, with release expected in mid-September.

* * *

The first of its kind in the region, a cooperative weed management agreement based on the requirements of the 1990 amendment to the Federal Noxious Weed Act was developed for Devil's Tower NM by park and regional staff. The agreement facilitates a partnership between the monument, Crook County, Wyoming, and local landowners for controlling noxious weeds on the monument and adjacent private lands. Under the agreement, a cooperative venture was initiated this year using goats to control leafy spurge as one part of an integrated program. The agreement will serve as a model for weed management partnerships at other parks.

* * *

The NPS, the State of Montana, and the Department of Justice executed a reserved water rights compact in late January describing the water rights of the U.S. for Big Hole Battlefield NHP and Glacier and Yellowstone NPs. The compact established a process for protecting water resources at the three parks. The hydrothermal systems and features of Yellowstone will be the most protected of their kind in

Regional Highlights

the world. The objective is to allow no impact to the geysers, mudpots, steam vents, and hot springs within the park.

* * *

Late last December, Colorado's water division #1 district court granted summary judgment to the U.S.' reserved water rights claims for national parks at Rocky Mountain NP. In granting these rights, the court said, "It appears that Congress in setting aside Rocky Mountain NP intended to reserve all of the unappropriated water in the park for park purposes. Only by doing so can the underlying purposes of the creation of the park be achieved."

* * *

Great Sand Dunes NM recently completed a prototype strategy that focuses resource management activities on achieving the park's purposes a little differently than in most resource management planning processes. The experimental effort differs in that it views park resources as part of a larger ecosystem and involves the public in learning about the park's purposes. Together, the groups defined the components and boundaries of the ecosystem, described the processes needed to understand, monitor, and manage it, and developed a feedback loop to evaluate the success of resource management actions on the system. The strategy also accepts human culture as part of the ecosystem and can be integrated into present resource management planning processes. Recently signed by the regional director, the Great Sand Dunes resource management strategy is available to parks to act as a model in developing their own similar products.

In the Next Issue. . .

NBS researchers will share results from both natural and social science projects in different areas of the country. Dick Hammerschlag will present a case study in marsh restoration for Kenilworth Marsh near Washington, D.C. Natalie Sexton plans to describe an innovative visitor study in Rocky Mountain NP that used visitor-produced photographs to determine the most important park attributes for the visiting public.

Meetings of Interest

1994

Nov. 14-18 **30TH ANNIVERSARY OF THE WILDERNESS ACT** at the Sweeney Conference Center in Santa Fe, NM; a five day conference sponsored by the NPS, NBS, BLM, USFS, USFWS, and Society of American Foresters Wilderness Group examining the intent of the act, recounting accomplishments, and strategizing for the 21st century. Research and operational issues are emphasized with partnerships potential and interagency management and research consistency to be explored. Contact Peter Keller, NPS Park Planning and Protection, Rm. 3230, 1849 C. St., N.W., Washington, D.C., 20240; or contact Alan Schmierer of the Western Regional Office at (415) 744-3959.

Oct. 19-22 **ECOSYSTEM MANAGEMENT AND RESTORATION FOR THE 21ST CENTURY** in Palm Beach Gardens, Florida; contact Bill Helfferich, South Florida Water Management District, P.O. Box 24680, West Palm Beach, FL, 33416-4680.

Oct. 24-27 **GEOLOGICAL SOCIETY OF AMERICA 1994 ANNUAL MEETING** in Seattle, Washington; *At the Leading Edge* is the theme for this popular conference. Sessions and symposia will be offered not only on aspects of Pacific Rim and convergent margin geology, but also on a variety of contemporary environmental and hydrogeological topics. Call (303) 447-2020 or (800) 472-1988 for program, registration, and lodging information.

Oct. 31- Nov. 4 **PARTNERS IN PALEONTOLOGY--FOURTH CONFERENCE ON FOSSIL RESOURCES** in Colorado Springs, Colorado; sponsored by Florissant Fossil Beds NM, the conference has broadened its scope to include fossil resources on all public lands and now integrates the BLM, USFS, USGS, and the Colorado State Lands Board as cooperators. Contact Maggie Johnston for further information at P.O. Box 185, Florissant, CO, 80816; or call (719) 748-3253.

Nov. 9-13 **FOREST CANOPIES: ECOLOGY, BIODIVERSITY, AND CONSERVATION** in Sarasota, Florida. The symposium will address canopy structure, organisms, processes, and aspects of forest conservation. Contact Dr. M. Lowman, Director of Research, Marie Selby Botanical Gardens, 811 S. Palm Ave., Sarasota, FL 34236, (813) 366-5731.

1995

Mar. 15-17 **ENVIRONMENTAL REGULATION AND PRESCRIBED FIRE** in Tampa, Florida at the Hilton Metro Center. The conference will provide a forum for prescribed fire practitioners and environmental regulators to discuss roles in maintaining ecosystem health, endangered species preservation, hazard fuels reduction, and air and water quality protection. Contact Diane Ots, Environmental Regulation and Prescribed Fire Conference, Center for Professional Development and Public Service, Florida State University, Tallahassee, FL 32306-2027, (904) 644-7453, fax 644-2589.

April 17-21 **EIGHTH CONFERENCE ON RESEARCH AND RESOURCE MANAGEMENT IN PARKS AND ON PUBLIC LANDS,** sponsored by The George Wright Society; Portland, Or. Theme: "Sustainable Society and Protected Areas--Challenges and Issues for the Perpetuation of Cultural and Natural Resources." Registration information available from the George Wright Society, PO Box 65, Hancock, MI 49930-0065

INFORMATION CROSSFILE

The USFWS and National Marine Fisheries Service published several new policies concerning endangered and threatened species in the **July 1 edition of the *Federal Register* on pages 34270-34275.**

USFWS also proposed downlisting the bald eagle from endangered to threatened, except in certain areas of the Southwest. In the five states where it is currently listed as threatened (Oregon, Washington, Minnesota, Wisconsin, Michigan), it would continue to be listed as threatened. Comments are being received until October 11 **(Federal Register July 12, pages 35584-35585).**

The USFWS ruled on a petition to list 83 mollusc species, finding that, for some species, substantial information indicating that listing is warranted was not presented, or, for other species, that listing is not presently warranted. The species considered are found primarily in the states of Washington, Oregon, California, and Idaho, and some are known or are believed to occur on NPS lands **(Federal Register July 11, pages 35305-35307).**

The Soil Conservation Service published a revised listing of the soils defined as "hydric soils," which are used in delineating wetlands **(Federal Register July 13, pages 35680-35695).**

The USFWS determined the water howellia (*Howellia aquatilis*), a wetlands plant, to be a threatened species. Although extirpated from California, Oregon, and some sites in Washington and Idaho, this species continues to exist in Montana, Idaho, and Washington, primarily in consolidated clay and organic sediments that occur in wetlands associated with ephemeral glacial pothole ponds and former river oxbows. Primary threats to the species are loss of wetlands and habitat changes due to timber harvesting, livestock grazing, residential development, and competition by introduced plant species such as reed canary grass **(Federal Register July 14, pages 35860-35864).**

* * *

Earlier this year, IUCN, the World Conservation Union, relaunched ***PARKS*, The International Journal for Protected Area Managers.** Published in February, June, and October each year, *PARKS* aims to strengthen international collaboration among protected area professionals and to enhance their role, status, and activities. Each issue is devoted to a theme. For example, volume 4, no. 1 explored building community support in protected areas and gave practical advice and instructive case histories on working with indigenous peoples. The reinvigorated publication costs £18 per year (approximately $30) with additional charges for postage. Contact *PARKS*, 36 Kingfisher Court, Hambridge Road, Newbury, RG14 5SJ, U.K., for subscription information.

* * *

A bacterium found in the digestive system of the bowhead whale has been found to be profoundly effective in breaking down key components of oil spills, PCBs, and other carcinogenic compounds. The **June 9 edition of Oregon State University's *OSU This Week*** describes the discovery by A. Morrie Craig, a professor of veterinary medicine. Craig said that despite eating a ton of polluted krill per day, and ingesting PCBs, oil and fuel residues, and acids, the whales don't get sick. Instead, the anaerobic microbes in the whale's forestomach break down anthracene and naphtalene, components of oil spills, into harmless compounds.

Researchers at OSU are also working on isolating bacteria from the stomachs of goats that allow them to digest tansy ragwort, a plant containing toxic alkaloids. While the research has a long way to go before yielding a toxic spill engineered-treatment, it suggests that anaerobic bacteria may one day be employed in along with today's surface aerobic bacteria to aid in toxic spill cleanups.

* * *

The **August 4 edition of the Rocky Mountain News** summarized a shift in Clinton administration science policy that upgrades non-military research that benefits health, prosperity, and the environment. The policy report named an 18-member committee to guide the federal science and technology expenditures.

* * *

A British research team reported in both the **January, 1994 issue of *BioScience* and the September 23, 1993 edition of Nature** that a method presently used by conservationists in selecting lands for the preservation of species diversity are flawed. Conservationists often decide which lands to preserve by evaluating species diversity and the presence of rare or endangered species within them. In using this strategy they frequently make the assumption that species richness for one group of plants or animals will be equally rich for another group, and that an area beneficial to a rare species will be a magnet to others.

J.R. Prendergast of Imperial College in Ascot, U.K. led a research team to look into the question and found no evidence that either assumption was true. They mapped nearly 2,700 ten-kilometer squares and then examined their data for overlapping areas rich in birds, butterflies, dragonflies, liverworts, and aquatic flowering plants. They found that only 12% of the dense bird and butterfly areas overlapped while no single square was rich in all five of the kinds of lifeforms. Only 26 of the squares were especially diverse in any three kinds of the taxa and 25% or more of the uncommon species from four of the groups were not found in any hot spot. While the authors/scientists admit that severe habitat fragmentation in Great Britain may indicate that the data would not also apply elsewhere, they were confident in their conclusions.

***

A comprehensive study of the complex wanderings of Greater Yellowstone Ecosystem (GYE) bald eagles is described in the spring 1994 edition of **Yellowstone Science.** Researcher Al Harmata's account of the near 15-year project discusses project growth from the initial leg-banding scheme to the more effective, but more expensive, radio-tracking methods used in the mid- to late-1980s. Yellowstone was once thought to be a "black hole" for bald eagles (a location where their population was declining and even "sucking in" recruits from outside the Yellowstone area), but Harmata's research demonstrated just the opposite.

Both the leg-banding and radio-tracking experiments indicated that juvenile and immature GYE-born eagles wander westward (rather than the common north or south movements in most areas) early in the fall and often winter from southern California to Washington. The young birds returned to their birth nest areas in and around the park usually in April or May before they dispersed throughout the ecosystem, and beyond, to live their lives and breed. Harmata shows that the GYE eagle population (while perhaps low in productivity by some comparisons) has a very high survival rate for young eagles and that this is significant in supplying recruits to expanding eagle populations outside the GYE.

The researchers also noticed that the summer wanderings of the Yellowstone eagles nicely delineate the boundaries of the GYE. As an indicator of ecosystem health, eagles in the GYE now appear to be successful and the knowledge gained about the biological "boundaries" of this ecosystem as discovered in this research project give an even stronger basis for the ecosystem's protection.

Harmata and his colleagues conclude with resounding confidence that the GYE eagles are not disappearing in Yellowstone, but are rather bolstering the comeback of our national symbol in surrounding areas.

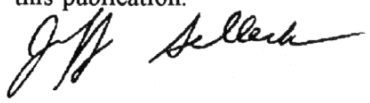
EDITORIAL

(*continued from page 2*)

numerous CPSU researchers. As editor, I want to strive for geographic balance in the articles published in *Park Science* just as I want to encourage participation by diverse authors as detailed in my article about writing for the bulletin. Have a look at the submission criteria and contact me if you have an idea for an article, a suggestion, or a concern.

In moving *Park Science* to Denver, most of the production that once fell to Jean and staff in the Pacific Northwest Regional Office now takes place here. I want to thank Shirley Clark, Pat Geegan, Hildred Vann, and Lynne and Dave McPhaden of that office for their help over the years. Shirley tracked the *Park Science* budget and gave general support; Pat coordinated Jean's travel; Lynne executed the printing and distribution contracts; and Hildred and Dave handled the regional office and international copies distribution. Richard Aroksaar and VIP Edith Miller of the PNRO library, will continue to generate the annual article indexes that we usually publish in the winter issue. Regional Chief Scientist Jim Larson (recently retired) is also to be thanked for serving as the *Park Science* Editorial Board Chairman since 1983. A big thanks to all for past and continued support!

I'm thankful for a smooth transition and a strong foundation to build on. I look forward to continuing the excellence of this publication.



Editor

BULK RATE
POSTAGE AND FEES PAID
U.S. DEPARTMENT OF THE INTERIOR
PERMIT NO. G-83